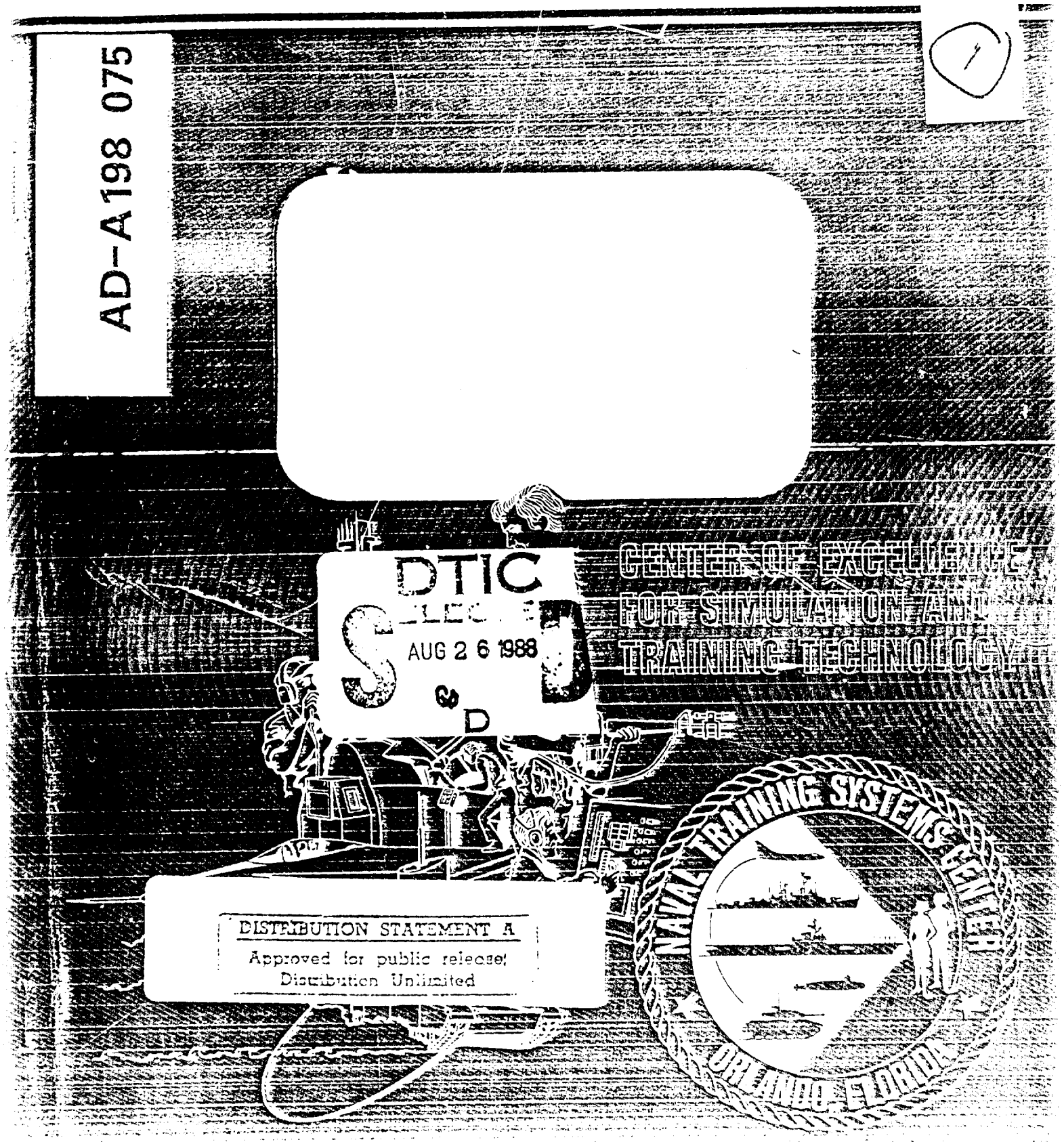
NAVAL TRAINING SYSTEMS CENTER
ORLANDO, FLORIDA



DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

(1)

TECHNICAL REPORT 87-016

THE EVOLUTION OF TEAMWORK SKILLS: AN EMPIRICAL ASSESSMENT WITH IMPLICATIONS FOR TRAINING

NOVEMBER 1987

Albert S. Glickman
Seth Zimmer
R. Craig Montero
Paula J. Guerette
Wanda J. Campbell
Ben B. Morgan, Jr.
Eduardo Salas

Prepared for:
OFFICE OF NAVAL RESEARCH
and
HUMAN FACTORS DIVISION
Naval Training Systems Center

DOD DISTRIBUTION STATEMENT
Approved for public release; distribution is unlimited.

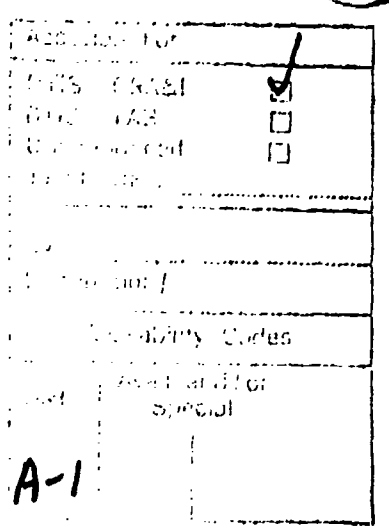
W.A. RIZZO, Head
Human Factors Division

H.C. OKRASKI, Director
Research and Development
Department

Technical Report 87-016

GOVERNMENT RIGHTS IN DATA STATEMENT

Reproduction of this publication in whole or in part is permitted for any purpose of the United States Government.



UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

ADA198075

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Technical Report, TR87-016	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Center for Applied Psychological Studies 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Office of Naval Research
6c. ADDRESS (City, State, and ZIP Code) Old Dominion University Norfolk, VA 23529-0267	7b. ADDRESS (City, State, and ZIP Code) 800 North Quincy Street Arlington, VA 22217-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Naval Training Systems Center 8b. OFFICE SYMBOL (If applicable) Code 712	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) Human Factors Division Department of the Navy Orlando, FL 32826	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 62233N; PROJECT NO. W3331; TASK NO 5716; WORK UNIT ACCESSION NO. DN7080017
11. TITLE (Include Security Classification) The Evolution of Teamwork Skills: An Empirical Assessment with Implications for Training	
12. PERSONAL AUTHOR(S) Albert S. Glickman, Seth Zimmer, R. Craig Montero, Paula J. Guerette, Wanda J. Campbell, Ben B. Morgan, Jr., Eduardo Salas	
13a. TYPE OF REPORT Final 13b. TIME COVERED FROM 9/86 TO 9/87 14. DATE OF REPORT (Year, Month, Day) 871115 15. PAGE COUNT	
16. SUPPLEMENTARY NOTATION This report was prepared under the Navy Manpower, Personnel and Training R&D Program of the Chief of Naval Research under Contract N000014-86-K-0732.	
17. COSATI CODES FIELD / GROUP / SUB-GROUP	18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Team Training, Team Performance, Training Intervention, Training Analysis, Team Development, Teamwork

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The findings reported here represent the results of the first phase of a three-year program of research designed to examine factors that influence the development of teamwork during training. The current study was conducted at the Naval Gunfire Support (NGFS) Department, Little Creek Amphibious Base, Norfolk, Virginia. It represents one component of a research effort seeking to document the processes involved in Team Evolution and Maturation (TEAM).

The primary objectives of this research are to: (1) delineate the process variables that comprise "teamwork"; (2) develop a set of instruments to measure these variables; (3) study how teamwork develops (i.e. how teams evolve and mature) over the course of training; and (4) develop means to diagnose, correct, and enhance team performance in training.

(CONTINUED)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Eduardo Salas and James Lester	22b TELEPHONE (Include Area Code) (407) 380-4651 22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

Block 19 (continued)

A model of team evolution and maturation was developed based on existing models and methodologies in the team performance/team training literature. This model hypothesizes that a team progresses through several different stages of development during the course of training, and that the speed and sequence of these stages is affected by the efficacy of the training program. In addition, the model postulates two separate developmental tracks--a "taskwork" track and a "teamwork" track. In order for training to be successful and for the group of individuals to function as a cohesive team, these two tracks must be separately developed and ultimately converged. (SDW)

Initial activities at NGFS involved the development and refinement of instruments designed to measure changes in teamwork behaviors that occur during the course of training. The results of these efforts were a series of measurement devices including a Critical Team Behaviors Form, a Trainee Questionnaire, and Demographics Form, a Gunnery Liaison Officer's (GLO's) Individual Performance Form, and an Instructor's Individual and Overall Performance Forms.

Data were collected on a total of 13 Navy teams. These were categorized as more and less effective teams according to an independent criterion (i.e., final exam score during training) and analyzed. Findings support the TEAM model and validate the sensitivity of the measurement instruments to detect both discrimination effects and evolution and maturation effects. In addition, the findings suggest the presence of a "taskwork" factor, a "teamwork" factor, and a "jelling" factor which occur as separate factors at the start of training but which converge during the final stage of training. Based on these results, preliminary interventions designed to improve team training effectiveness are suggested. Further research in other team training settings is needed to determine the generalizability of the present findings.

FOREWORD

This document represents the final report of research conducted under ONR No. N00014-86-K-0472. The project was sponsored by the Human Factors Division, Naval Training Systems Center (NAVTRASYSCEN), Department of the Navy, Orlando, FL, 32813. Preparation of this report was done with the assistance of Sandra Jacobson, Teri Pedigo, Randall Oser and Ladana Lindsey. Their contributions are gratefully acknowledged.

Valuable and creative inputs regarding data analysis and interpretation were provided by consultants Drs. Robert W. Swezey, Behavioral Sciences Division, Systems Applications International Corporation, McLean, VA, 22102; Lawrence R. James, Georgia Institute of Technology, Atlanta, GA, 30332; and Glynn D. Coates, Old Dominion University, Norfolk, VA, 23508. In addition, appreciation is expressed to Ms. Elizabeth Woodard and Mr. Robert Delprino for their assistance in analyzing the demographics data.

Great appreciation is also expressed to Commander, Training Command, U.S. Atlantic Fleet, Norfolk, VA; Commanding Officer Naval Amphibious School, Little Creek, for his cooperation and agreement to participate in the research and to Lt. Thomas Grafton, Naval Gunfire Support (NGFS) Department, Naval Amphibious School, Little Creek for his personal insights and co-ordination assistance. We would like to thank the instructors and NGFS support personnel who showed great expertise when working with the researchers and patience and persistence when asked to complete lengthy data forms. Finally, we are grateful for the cooperation of the trainees and their ship commands, without which this phase of research would not have been successful.

THIS PAGE INTENTIONALLY LEFT BLANK.

EXECUTIVE SUMMARY

The findings reported here represent the results of the first phase of a three-year program of research designed to examine factors that influence the development of teamwork during training. The current study was conducted at the Naval Gunfire Support (NGFS) Department, Little Creek Amphibious Base, Norfolk, Virginia. It represents one component of a research effort seeking to document the processes involved in Team Evolution And Maturation (TEAM).

The primary objectives of this research are to: (1) delineate the process variables that comprise "teamwork"; (2) develop a set of instruments to measure these variables; (3) study how teamwork develops (i.e., how teams evolve and mature) over the course of training; and (4) develop ways to diagnose, correct, and enhance team performance in training.

A model of team evolution and maturation was developed based on existing models and methodologies in the team performance/team training literature. This model hypothesizes that a team progresses through several different stages of development during the course of training, and that the speed and sequence of these stages is affected by the efficacy of the training program. In addition, the model postulates two separate developmental tracks --a "taskwork" track and a "teamwork" track. In order for training to be successful and for the group of individuals to function as a cohesive team, these two tracks must be separately developed and ultimately converged.

Initial activities at NGFS involved the development and refinement of instruments designed to measure changes in teamwork behaviors that occur during the course of training. The results of these efforts were a series of measurement devices, including a Critical Team Behaviors Form, a Trainee Questionnaire, a Demographics Form, a Gunnery Liaison Officer's (GLO's) Individual Performance Form, and an Instructor's Individual and Overall Performance Forms.

Data were collected on a total of 13 Navy teams. These were categorized as more and less effective teams according to an independent criterion (i.e., final exam scores during training) and analyzed. Findings support the TEAM model and validate the sensitivity of the measurement instruments to detect both discrimination effects and evolution and maturation effects. In addition, the findings suggest the presence of a "taskwork" factor, a "teamwork" factor, and a "jelling" factor, which occur as separate factors at the start of training but which converge during the final stage of training. Based on these results, preliminary interventions designed to improve team training effectiveness are suggested. Further research in other team training settings is needed to determine the generalizability of the present findings.

THIS PAGE INTENTIONALLY LEFT BLANK.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES(Continued)

THIS PAGE INTENTIONALLY LEFT BLANK.

THE EVOLUTION OF TEAMWORK SKILLS: AN EMPIRICAL ASSESSMENT WITH IMPLICATIONS FOR TRAINING

"Of all the missions a ship is required to accomplish, none require greater teamwork than NGFS. To become proficient at this demanding task, both formal training and frequent practice are required" (COMNAVSURFLANTINST 3570.2C, 1982).

OVERVIEW

This report describes a comprehensive investigation of the factors that contribute to the development of teamwork during the operational training of Navy teams. The investigation was conducted at the Naval Gunfire Support (NGFS) Department, Little Creek Amphibious Base, Norfolk, Virginia. It represents one component of a broader program of research that has been designed to investigate Team Evolution And Maturation (TEAM). The primary goals of this research program are to:

1) delineate the process variables that comprise "teamwork";

2) develop a set of instruments to measure these variables;

3) increase the understanding of how teamwork develops (i.e., how teams evolve and mature) over the course of training; and

4) develop ways to diagnose, correct, and enhance team performance in training (thus enhancing the efficiency and effectiveness of team training systems).

Earlier work in this program has provided a thorough review of the relevant literature, the articulation of a model of team development, instruments to measure team evolution and maturation, and preliminary observations of teams undergoing training at NGFS (all related to goals 1 and 2 above). Descriptions and results of these prior efforts have been reported by Morgan, Glickman, Woodard, Blaiwes, & Salas (1986).

ORGANIZATION OF THE REPORT

The present report presents the results obtained with data collected at NGFS and discusses the implications of the findings for improving team training systems (related to goals 3 and 4 above). These results provide an initial appraisal of the validity of the instruments and procedures developed in the earlier phases of the research. In addition, they document the nature of the changes in team behaviors and their impact on the effectiveness of team performance. They also provide a basis for suggestions of ways in which NGFS training can be improved. When

combined with the results of later phases of this research program, the current data will provide a basis for the construction of new training aids, programs, or instructional approaches of more general applicability that will add to the quality of team training in the Navy.

The introductory section of the report discusses the factors that have contributed to the development and design of the present research effort. This includes a brief discussion of the knowledge gaps that have resulted from prior research, the types of questions which stimulated the present research, and a summary recapitulation of the theoretical and descriptive models upon which the current investigation is based. The method section describes the various measurement instruments and procedures used to collect data at NGFS. The results section presents an overview of the data collected and describes evidence which indicates the presence of evolution and maturation effects in the NGFS teams. This section also illustrates the fact that the measurements provide a basis for discriminating between more effective and less effective teams. It ends with a summary which highlights the most important findings. The discussion section provides additional insights concerning the implications of the current findings as they relate to the theoretical and conceptual framework, the measurement techniques, and the analyses employed in the current investigation. In addition, the results are discussed in terms of their application to team training systems design and development in the Navy. Finally, specific training interventions are suggested for further investigation and evaluation during the next stage of the research program.

INTRODUCTION

This research focuses on the investigation of operational Navy teams undergoing prescribed training in state-of-the-art simulation facilities. It is based on the supposition that a fuller understanding of the behaviors that represent the evolution and maturation of teamwork in such teams will contribute substantially to the Navy's overall effort to maximize the effectiveness of its team training systems.

For purposes of this research, "team" has been defined as "a distinguishable set of two or more individuals who interact interdependently and adaptively to achieve specified, shared, and valued objectives" (Morgan, et al., 1986). Similarly, teamwork is defined as consisting of those actions, processes, and behaviors which contribute to a team's ability to interact interdependently and adaptively in order to achieve specific, shared, and valued objectives in a most efficient manner. This includes behaviors related to the development of effective team communication, coordination, cohesion, cooperation, etc. Teamwork is considered to be enhanced through purposefully committed person-to-person activities designed to improve

operational task performance, communication skills, and interaction patterns within the team.

BACKGROUND

Earlier research (e.g., Goodstadt, Frey & Glickman, 1975) has shown that the relationships among social/occupational variables are different at different phases of the socialization process in military service. Similarly, Terborg, Castore, & Dinnino (1976) found that the influence of attitude similarity on group cohesion was not immediately apparent, but that these effects developed over time. These findings support the supposition that factors which influence group performance must be studied over time, as the group changes. Nevertheless, one of the major shortcomings of previous team training research has been the failure to give specific attention to the learning of teamwork skills (cf. Cissna, 1984; Denson, 1981; Dyer, 1984), and to improving the understanding of how various patterns of team-member interactions develop, change, and impact performance during the life-cycle of the team.

Although the need for investigations of group and team development has been expressed frequently, it has likewise been noted that substantial gaps exist in the scientific understanding of how to analyze, define, measure, design, and evaluate team training and its components (cf., Alluisi, 1977; Baum, Modrick, & Hollingsworth, 1981; Denson, 1981; Goldin & Thorndyke, 1980; Hall & Rizzo, 1975; Nieva, Fleishman, & Reich, 1978; Dyer, 1984). As pointed out by Salas, Blaiwes, Reynolds, Glickman, and Morgan (1985), problems particularly relevant to the current research include the inability to adequately define the variables that contribute to effective teamwork, a lack of integrative conceptualizations, inadequate measurement systems, and limited knowledge of how teams develop over time.

One reason for the limited understanding of team development is that most of the previous research has dealt with mature teams. In addition, inadequate understanding of team learning processes--particularly as they relate to the ways in which teams learn to work together over time--have inhibited advances in the development of team training instructional systems. Research in this area has also been hindered by the inherent complexities of group interactions, the assorted difficulties involved in observing teams at work, and the practical constraints imposed upon efforts to conduct longitudinal studies.

In the Navy, as in most other organizations, team performance has often been based on faith in the "natural evolution" of teamwork, with "trial and error" characterizing the formulation of training procedures. The example of athletic (e.g., basketball) teams is often cited to point out that it takes time--experience working with one another--for individuals

to learn to work as a team, and that the coach (i.e., instructor) makes an important difference in the ultimate success of the team. Everyone "knows" this, but there is relatively little understanding of what team members or instructors actually do that accounts for the differences between good and poor teams. For the most part, instructors provide "team" training only by providing team members with the opportunity to practice their individual skills in a group setting (Salas et al., 1985). Feedback concerning the behaviors that comprise teamwork is usually lacking. Trainees receive instruction in teamwork, as such, only to the extent that instructors are able to devise ad hoc ways to teach them (Morgan et al., 1986).

While it is common to assert that "a team is more than the sum of its parts," relatively little is known about the social and organizational processes that make this so or about how roles and patterns of interaction emerge and evolve during training (or during the total life history of a team). Thus, a number of questions arise concerning the nature of team evolution and maturation. For example,

* Which variables determine how well a team does its work, and at what stages of team evolution and maturation are these variables most salient?

* What kinds of teamwork behaviors occur at the various stages of training?

* What is the nature of teamwork? How should it be defined? How can it be measured?

* What training variables affect the rate of team maturation?

* What do people need to learn about working with one another in order to enhance the outcome of the collective effort?

* What kind of teamwork training should be provided along with the technical skills training typically provided in Navy training?

* What instructional technology or procedures may enhance teamwork?

These are the kinds of questions that have provided the impetus for the current research (see also Cissna, 1984; Denson, 1981; Dyer, 1984). Stimulated by questions such as these, efforts during the first year of this research resulted in the development of several models to guide the planning and conduct of the research. The first of these was an overall descriptive model of the ongoing sequence of processes by which teams evolve, mature, and improve their performance over time. Two additional models were developed to represent the specific stages and processes involved in NGFS training. These models are discussed

below in order to provide a better understanding of the background, conceptual framework, and objectives for this investigation. Additional details concerning the models and their development are available in Morgan et al. (1986).

RESEARCH OBJECTIVES

During the initial year of this research program, a review of the literature was conducted in order to identify previous findings, hypotheses, and concepts concerning the temporal evolution of teams. This effort resulted in the development of a model of team evolution and maturation (the TEAM model), which was designed to represent the available conceptualizations of how teams develop over time, and to stimulate hypotheses to guide the current measurement of team evolution and maturation. The objectives of the current investigation can be illuminated by a brief discussion of this model.

The TEAM model has its origins in an open systems framework of organizational effectiveness developed by Glickman, Goodstadt, Kavanagh & Bass (1977). As illustrated in Figure 1, this framework considers team performance as a dynamic activity of process-outcome linkages which occur within an environmental envelope of organizational and other exogenous forces.

The TEAM Model

The TEAM model is presented in Figure 2 (for a detailed exposition of the model, see Morgan et al., 1986). The concepts embodied in this model, and the literature on which it is based, suggest that : 1) the processes involved in the development of a team change over time; 2) these processes form continuous process-outcome linkages with intermediate outcomes serving as inputs for future processes; 3) team members learn teamwork skills as a result of experience within the team; and 4) the experience and learning acquired by team members will induce changing behavior patterns over time. The TEAM model also depicts the variables involved in the processes by which members learn the demanding, adaptive, interdependent actions that are required to achieve the team's performance objectives.

The TEAM model also incorporates nine stages of team development (i.e., preforming, forming, storming, norming, performing-I, reforming, performing-II, conforming, and de-forming) that have been suggested by several other authors (e.g., Bales & Strodtbeck, 1951; Bell, 1982; Bennis & Shepard, 1956; Caple, 1978; Fisher, 1970; Gersick, 1985; Tuckman, 1965; Tuckman & Jensen, 1977). Thus, it describes a series of developmental stages through which task-oriented teams are hypothesized to evolve, beginning with initial levels of incompetence and

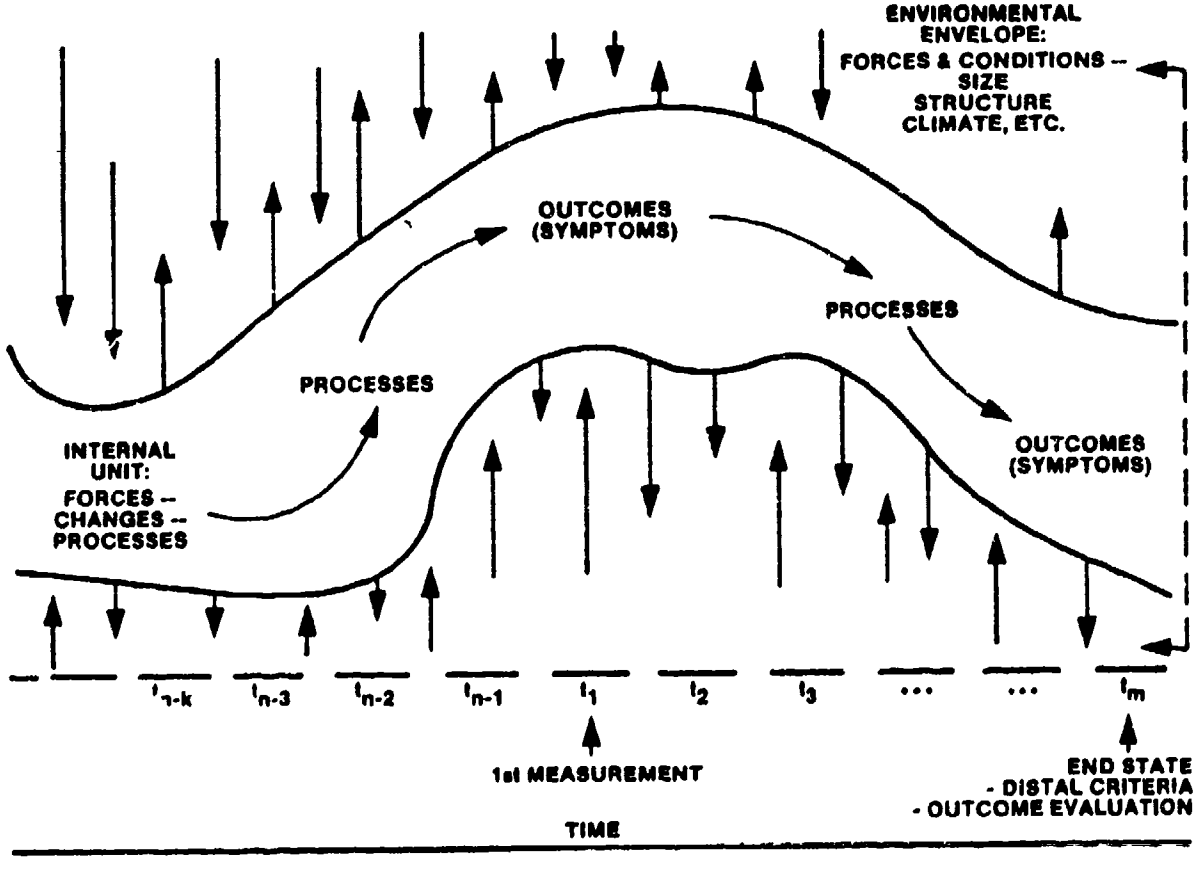


Figure 1. Dynamic organizational effectiveness model.

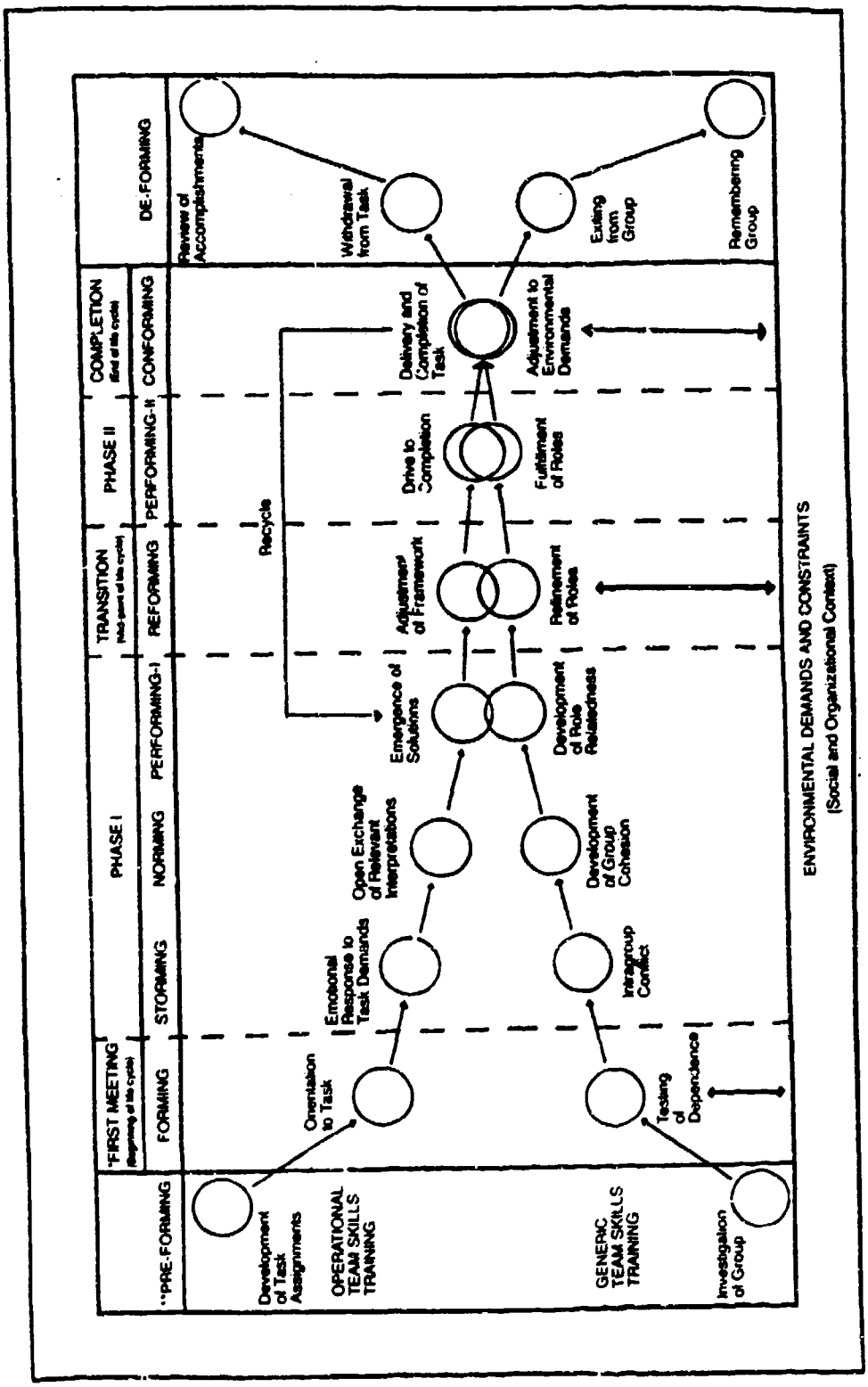


Figure 2. A general model of team evolution and maturation.

This test site was selected because it met the requirements of a set of previously established guidelines (see Appendix A) which were based on visits and interviews with key personnel at several prospective research sites. In addition, several factors made NGFS particularly attractive as a test bed for the hypotheses and objectives of this investigation: (1) Shipboard gunfire support teams on combat vessels are required to begin their training cycle with NGFS; (2) The membership of the team is required to remain intact during attendance at the school and live firing exercises scheduled to take place within 90 days after school training; (3) On-line performance scores are available from midterm and final tests conducted on the shore bombardment simulator at the school and from subsequent qualification tests conducted at a live firing range; (4) The teams are required to complete training at the school, and then at the live firing range, in order to be certified as being in a state of readiness to deploy with the fleet. This last fact is perhaps most important from a motivational standpoint. The serious repercussions associated with training failures (e.g., notification to Congress of the failure to attain operational readiness) provide a strong incentive for the ships' commanders to ensure that the training and live-fire requirements are taken seriously. In turn, this serves to increase the perceived "reality" of the NGFS training for the individual members who are assigned for such training.

At the time of this investigation, training at the NGFS school consisted of a morning orientation (pre-exercise) session (usually on Monday) and 3 1/2 to 4 1/2 days of subsequent simulator exercises (Some changes have been made in the content and structure of NGFS training since this study was conducted). The simulator training is divided into five phases of increasingly difficult exercises: basics, pre-midterm, midterm, post-midterm, and final. In spite of the requirement that individual team members come to training with a relatively high degree of proficiency on assigned tasks, it was found that teams typically include several new members who have little or no actual gunfire support experience. However, the Navy requires that the individuals who form the team that is trained at NGFS also constitute the team that conducts the live firing on the range. While exceptions may be made in the case of serious problems that necessitate the substitution of team members, these must be made during the course of training at the school. The team that the school determines to be qualified is the team that is expected to shoot live ammunition.

Crews engaged in NGFS training are composed of three teams: the Bridge team, consisting of approximately three members; the Combat Information Center (CIC) team, consisting of eight members; and the Plot team, consisting of five members. The teams may or may not be physically separated (depending upon the class of ship). Communication between the teams is accomplished through the use of sound-powered telephones. Transmissions, which in

actual combat would take place between the ship and the shore-based spotter who is directing the shore bombardment, are simulated by the school staff.

The CIC team was chosen as the object of observation for this investigation because CIC is the hub of NGFS activity, and it requires the greatest amount of communication, interdependence, and interaction. It interfaces with the two other shipboard teams as well as with the spotter. Furthermore, findings from the CIC at NGFS should generalize to the many other Navy teams whose modus operandi resemble the team situation simulated at NGFS. The following section discusses the training of the CIC team in terms of the nature of the interactions among the instructor, the team, and individual team members.

Component Model of NGFS Training

As described above, NGFS training occurs in six sequential phases : pre-exercise, basic missions, pre-midterm, midterm, post-midterm, and final. In addition, the NGFS training system consists of three separate but interactive components: the instructor, the individual, and the team. In order to illustrate the relative importance of each component, as well as changes in each component's importance and level of interaction throughout the course of training, a model was developed to represent the activities, contributions and interactions of each component during the phases of NGFS training. This model is reproduced in Figure 3. For a detailed description of this model and subsequent refinement of the instructional process model, see Morgan et al. (1986) and Guerette, Miller, Glickman, Morgan and Salas (1987).

In this model, the relative importance of the instructor, the individual, and the team to the overall training effort is represented by the size of the box containing each component--the larger the box, the more important the component during that given phase of training. The general direction of flow of information, feedback, and other contributions, as well as the relative amount of each of these processes, is indicated by the direction and number of arrows interconnecting the three components. Typical behaviors are listed by phase for each component. Instructor behaviors are separated into those that are directed at the individual and those targeted at the team.

As depicted in Figure 3, it was hypothesized that at the start of training the importance of the individual and the instructor is large relative to the importance of the team. At this point, the general flow of contribution is from the instructor to the individual, and to a lesser degree, to the team as a whole. As training progresses, the instructor's contribution to the development of the team as such increases and the relative importance of the team component also increases.

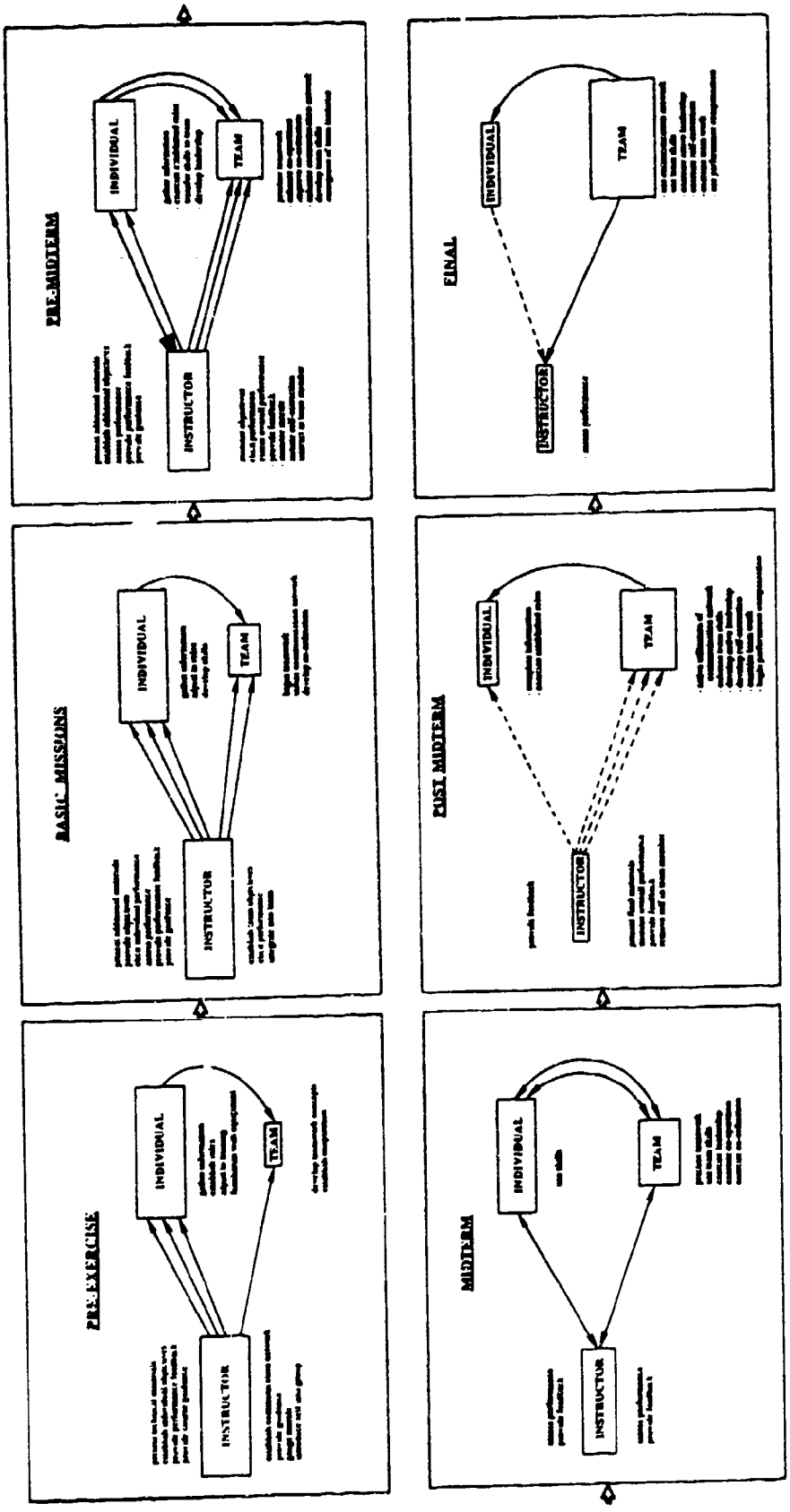


Figure 3. Component model of Naval gunfire support training.

Gradually, the role of the instructor diminishes as he transfers "ownership" to the team. Finally, the team becomes the dominant component, from which contributions flow to both the individual and the instructor.

Stage Model of NGFS Training

As suggested previously (see Morgan et al., 1986), NGFS training can also be understood in terms of its relation to the stages of team development represented in the TEAM model (Figure 2). In Figure 4, the six phases of NGFS training are presented in the format of the TEAM model, with the phases of NGFS training incorporated beneath the stages of evolution and maturation. Vertical lines have been included to allow comparison between the stages of the TEAM development process and the phases of NGFS training. The individual circles have been labeled with representative behaviors from each phase. The purpose of this model is to suggest that NGFS training will result in temporally changing patterns of team behaviors that can be measured and related to success in simulator training.

Summary of Objectives

The purpose of this investigation was to measure the changes in team behavior that contribute most to the development of teamwork skills during operational training. It was hypothesized that changing behavior patterns could be measured during NGFS training and that these patterns could be related to increases in teamwork skills. It was also expected that these changing behavior patterns would reflect changes in both taskwork and teamwork activities and that a convergence of these skills could be demonstrated in successful NGFS teams.

Thus, the current investigation was designed to provide specific information concerning the evolution and maturation of teams in training, suggestions of ways to improve team training systems in the Navy, and validation of the TEAM model and measurement procedures. In summary, the objectives of this research were to (1) identify and define the processes and behaviors that constitute teamwork, (2) demonstrate the utility of a set of instruments designed to measure these processes and behaviors, (3) measure the evolution and maturation of NGFS teams during training, and (4) develop suggestions of ways to diagnose, correct, and enhance team training.

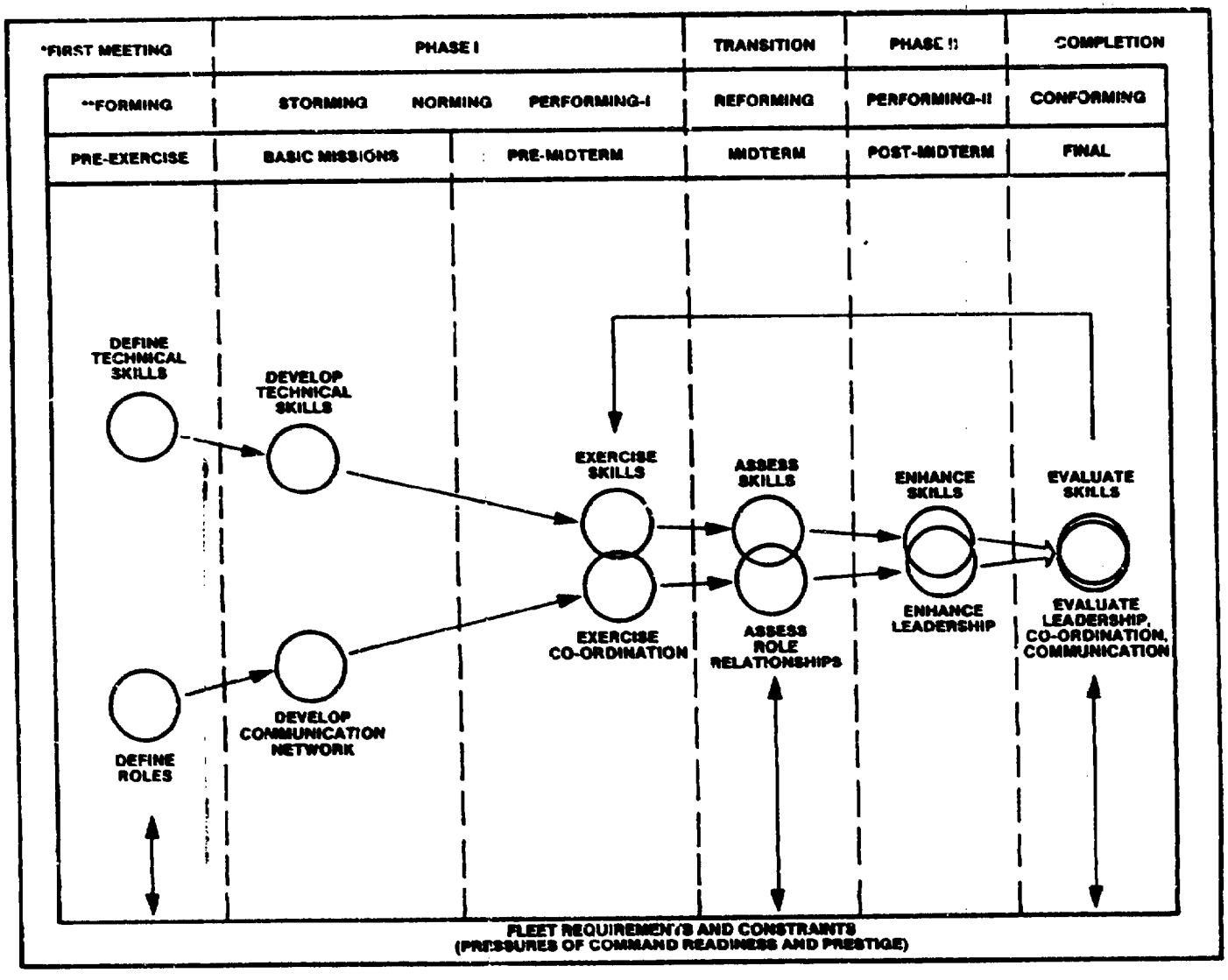


Figure 4. Stage model of Naval gunfire support training.

THIS PAGE INTENTIONALLY LEFT BLANK.

METHOD

The TEAM measurement procedures were employed in the collection of data from a total of 17 teams undergoing gunfire support training at NGFS. For a variety of reasons, final data sets were incomplete for four of these teams (one team failed the midterm examination and returned to the ship without completing the remaining training sessions, and schedule conflicts prohibited the collection of data for one or more sessions with the other three teams). Thus, complete data sets were collected for a total of 117 individuals representing 13 teams trained by six different NGFS instructors. The specific data collection instruments and measurement procedures employed in this investigation are discussed below.

DEVELOPMENT OF TEAM MEASUREMENT TECHNIQUES

Based on direct observations of team training and interviews with NGFS instructors, six data collection instruments were developed for use in this investigation (see Morgan et al., 1986). Three of these forms were completed by the instructors. These are: (1) the Critical Team Behaviors Form, which was designed to identify critical behaviors displayed by the instructor and the team members; (2) an Overall Team Performance Form which requires the instructor to evaluate the overall performance of the team as a whole; and (3) an Individual Performance Summary designed to evaluate the effectiveness of individual team members in the performance of their assigned duties.

In addition, the formal team leader--the Gunnery Liaison Officer (GLO)--was asked to complete the Individual Performance Summary in order to provide his estimates of the performances of the individual members of his team. Two data collection instruments were also completed by the team members themselves: (1) a Self-Report Questionnaire which was used to record the changing perceptions of the team members and (2) a Team Demographics Form which provided information on prior work and training experiences related to NGFS and the Navy in general. A more complete description of each of the measurement instruments is provided below; copies of the forms are provided in Appendices B through G.

With the exception of the Demographics Form, which was completed on the afternoon of the first day of training, all of the forms were designed to be completed after each morning and afternoon session during the week of training. In order to maximize completeness and accuracy of recall, all individuals were asked to base their responses to the questionnaires on observations that were made during the last exercise of the just-completed session.

DATA COLLECTION FORMS

Instructor Forms

Critical Team Behaviors Form. A critical incident approach (Flanagan, 1954; Glickman & Vallance, 1958) was used to develop the Critical Team Behaviors Form, which was used by the instructors as a means of identifying specific effective and ineffective behaviors of team members. A sample of this form is given in Appendix B. The critical incident technique was adapted here to take advantage of the instructors' expert knowledge of the team member behaviors that are linked to team success or failure. Another purpose was also served by involving the instructors in the development of this instrument. Namely, incidents that have high salience for instructors should also be expected to have high face validity for their cohorts, thus increasing their meaningfulness when translated into research findings and recommendations for operational application.

The first step in the development of the Critical Team Behaviors Form was to conduct semi-structured interviews with the NGFS instructors. The instructors were asked to describe previously observed incidents involving behaviors which differentiate more effective from less effective teams on a variety of performance dimensions. Instructors were also questioned about the importance of several aspects of team performance that were identified from the literature review that resulted in the TEAM model (Morgan et al., 1986). Then they were asked to provide examples of effective and ineffective behaviors related to the identified dimensions of team performance. In order to ensure that no important variable was overlooked, the results of the interviews were supplemented by research staff observations of teams undergoing NGFS training.

The interviews were tape recorded and transcribed. A list of critical events was then derived from the transcriptions, and the resulting items were sorted into seven a priori dimensions. In order to ensure that the broadest possible range of behaviors were available to represent each dimension, additional interviews were conducted. These interviews were also tape recorded, transcribed, and content analyzed. In the final categorization, over ninety critical incidents were sorted into the following dimensions: communication, adaptability, cooperation, acceptance of suggestions or criticism, giving suggestions or criticism, team spirit and morale, and coordination.

In the initial draft of the Critical Team Behaviors Form, effective critical behaviors were separated from those that were classified as ineffective in their consequences for team training and performance. Each page of the form contained either effective or ineffective behaviors for a given dimension. Instructors were asked to place an "X" in the box under the position of each of

the members involved in an observed critical incident, denoting the initiator of the behavior by circling the appropriate "X".

This initial version of the Critical Team Behaviors Form was pilot tested through an iterative process that produced several minor modifications. After the instructors had used the form at least once, they were asked to identify behaviors which they considered to be unimportant or which occurred only infrequently during training. As a result of these efforts, the form was revised so as to present both effective and ineffective behaviors for a given dimension in random order on the same page, thereby reducing the form to about half of its original length. Finally, a page entitled "Infrequent Incidents" was added in order to allow instructors to report behaviors which occurred only rarely, but which were considered to be important when they did occur. After becoming familiar with this list of infrequent behaviors, the instructors were only required to refer to this page on the rare occasions when one of these behaviors did occur.

From discussions with the instructors, it was learned that certain behaviors were thought to have greater impact than others. Consequently, an "impact" column was added and instructors were required to rate the importance of each behavior on a three-point scale. Also, at the suggestion of the instructors, a "frequency of occurrence" column was added to the Communication and Cooperation dimensions because behaviors within these dimensions could occur more than once within a given exercise.

The Critical Team Behaviors Form is currently 10 pages in length and it contains a total of 68 behavioral items (see Appendix B). It requires up to 45 minutes to complete. The cover sheet contains the instructions and a table of contents, as well as questions regarding the ship, the training session (day of training, morning or afternoon), and the training exercise just completed. Each of seven pages contains a single dimension with a list of effective and ineffective critical team behaviors. Another page contains the list of infrequent behaviors, and the last page provides space for listing important happenings that are not covered in the preceding sections.

Overall Team Performance Form. The second form requires the instructor to provide an overall appraisal of the performance of the team. At the end of each morning and afternoon session, instructors were asked to rate the team's performance on a five point scale ranging from 1 (very good) to 5 (very poor). Descriptive anchors were provided for points 1, 3, and 5. Additionally, instructors were asked to list three team strengths and weaknesses and to identify the training session just completed. The space for the strengths and weaknesses gave the instructors a chance to supply any additional input which they considered to be relevant. The form required about five minutes to complete. A copy of this form is found in Appendix C.

Individual Performance Summary. The third form completed by the instructors required an appraisal of the performances of the individual team members. Ratings were made on a five point scale ranging from 1 (very good) to 5 (very poor) to indicate the performance effectiveness of each team member during each phase of training. Instructors were also asked to indicate the current session of observation. This form required about three minutes for the instructor to complete. A copy of the form is found in Appendix D.

GLO Individual Performance Summary

The team's Gunnery Liaison Officer (GLO) was also required to rate the effectiveness of the performances of individual team members. The form used for this purpose is identical to the Individual Performance Summary completed by the instructor, except that the GLO was not required to evaluate his own performance. A copy of this form is found in Appendix E.

Team Member Forms

Trainee Self-Report Questionnaire. Based on the work of James, Gustafson, and Sells (1985), a 23-item self-report questionnaire was developed to measure the changing perceptions of trainees regarding individual and team abilities, motivation, and expertise. The questionnaire was designed to address the dimensions that relate to individual skills as well as those that relate to the team as a whole. The dimensions associated with individual skills include: (1) knowledge of duties, (2) motivation, (3) role clarity, and (4) experience and training. Dimensions dealing with teamwork include: (1) communication, (2) cooperation and coordination, (3) experience and prior training, and (4) power relationships. Items were adapted for both of these categories and then pilot-tested for readability and redundancy. No major problem was identified with regard to readability. However, based on some complaints concerning redundancy, several items were reworded to produce the final version of the form.

The Trainee Self-Report Questionnaire was administered after each morning and afternoon session beginning with Monday afternoon and concluding when the training was completed. Team members were requested to identify their position on the team and to respond to the questions in terms of observations made during the last exercise of the just-completed training session. Twenty-one of the questions used a 5-point scale with corresponding descriptive anchors that ranged from "strongly disagree" to "strongly agree." The final two items on the form requested each team member to list the positions of the "most

valuable" and "least valuable" players on the team. The team positions were listed randomly above the items and assigned a corresponding number which was to be recorded in the space provided after each item. Between five and ten minutes were required for the team members to complete this form. A copy of this questionnaire is given in Appendix F.

Team Demographics Form. This form was developed to gather information regarding overall Navy and NGFS experience of the team members. The form was pilot tested and revised three times in order to achieve economy of administration and consistency of answers (e.g., the term "rate" often was confused with "rank"). The final version of the form, which was administered during the afternoon of the first day of training, required between five and ten minutes to complete. This form is reproduced in Appendix G.

DATA COLLECTION PROCEDURES

The typical training scenario required between four and five days, depending upon the competencies and motivations of the team. Data collection began on Monday afternoon and was completed immediately after the team passed its final examination, usually on Thursday afternoon or Friday morning. Except for the Demographics Form, which was completed only once on Monday afternoon, all forms were administered at the end of each morning and afternoon training session; administration was scheduled to follow the sessions so as not to interfere with the normal flow of training. This schedule allowed data to be collected at least once during each of the five simulator phases of training. However, since a greater amount of training time was usually allotted to the pre-midterm and post-midterm phases, data were often collected more than once during these phases.

Teams reported for training on Monday morning of a given week. The pre-exercise phase of training began with a classroom briefing concerning the purposes and terminology of NGFS training. This was followed by a film, which demonstrated the types of missions served by gunfire support teams, and a tour of the NGFS simulator facilities in which the training exercises were subsequently performed. As part of the overall briefing, instructors informed the trainees about the nature and purposes of the TEAM data collection effort.

On Monday afternoon, the trainees completed the basic missions phase of training, which began with a lecture concerning the objectives of the exercises that were to be practiced during these basic missions. They were then provided approximately three and a half to four hours of training in performing the basic gunfire support missions. At the end of this session, a member of the TEAM research staff gave the trainees a short briefing concerning the nature of the data collection

instruments, the data collection schedule, and the procedures to be followed during each data collection period. Complete instructions were given, all questions were answered, and the first set of forms was administered. A member of the TEAM staff distributed the appropriate forms to the instructor and trainees, and collected the forms as they were completed.

As training progressed through the remainder of the week, TEAM staff members coordinated their efforts with those of the instructors so that a member of the research staff could be available at the end of each morning and afternoon session in order to administer the various data collection instruments. Each administration required approximately 10 minutes of the team members' time and 45 to 50 minutes of the instructor's time. Following data collection after the last session (at the end of the final examination phase of training), the instructors and trainees were thanked for their participation in the data collection efforts and all of their final questions concerning the investigation were answered.

RESULTS

OVERVIEW

The six data collection instruments provided responses for a total of 117 individuals from the 13 teams that completed training during this investigation. These data will be reported in the following sections, which separately present findings based on data from the Demographics Form, performance indices provided by the graded training exercises and performance rating scales, the Critical Team Behaviors Form, and the Trainee Self-Report Questionnaire. In each case, the reported analyses will focus on two major issues: (a) providing a description of the evolution and maturation of teams, and (b) identifying the characteristic differences between the highest performing and lowest performing teams. Evolution and maturation effects will be examined in terms of the changes in teams' performances, behavior patterns, and questionnaire responses over the phases of training. Discrimination effects will be examined in terms of similar differences among the teams. For the purposes of these analyses, data from each morning and afternoon data collection session have been assigned to represent the training phase that was in progress at the time of the data collection. When two or more data collection sessions occurred during a given phase of training, data were combined so as to provide a single data point for that phase.

DEMOGRAPHICS OF THE SAMPLE

Although the guidelines for NGFS training prescribe that CIC teams will consist of eight team members, the teams in the current sample ranged in size from seven to twelve, with an average of nine team members. However, data from the Demographics Form indicate that the individuals in this sample were relatively inexperienced in NGFS performance. This is illustrated in Table 1, which provides summary data from five of the twelve questions on the Demographics Form. Specifically, the table describes the sample in terms of the team members' rank, years in the Navy, years of NGFS experience, prior schoolhouse training, and frequency of NGFS practice.

These data indicate that 75% of the sample were enlisted men, and nearly 63% held the rank of E5 or lower. Nearly 35% of the sample reported having less than two years of service in the Navy and almost 72% had less than five years in the Navy. Similarly, approximately 64% of the trainees had less than one year of NGFS experience; only 6% reported having more than two years of such experience. Furthermore, only about one-half of the sample had ever been exposed to formal NGFS training, and approximately 32% had never practiced NGFS procedures aboard

Table 1

Demographic Characteristics of the NGFS Sample

Rank in the Navy

	E2	E3	E4	E5	E6	E7-9	O1	O2	O3	NA
Frequency	1	15	30	27	11	3	8	6	9	6
% of Total	0.8	12.9	25.9	23.3	9.5	2.6	6.9	5.2	7.8	5.2

Years in the Navy

	Less than 1	1-2	3-4	5-6	7-8	9-10	11 or more
Frequency	5	35	43	12	4	11	6
% of Total	4.3	30.2	37.1	10.3	3.4	9.5	5.2

Years in NGFS Training

	Less than 1	1-2	3-5	NA
Frequency	74	32	7	3
% of Total	63.8	27.6	6.0	2.6

Prior NGFS Training

	No	Yes
Frequency	56	60
% of Total	48.3	51.7

Frequency of NGFS Practice

	Never	Twice a Month, or less	More than Twice a month
Frequency	37	41	38
% of Total	31.9	35.3	32.8

ship. The sample was divided roughly into thirds on the basis of the frequency of NGFS practice, with only about 33% practicing more than twice per month. Overall, these data indicate that the typical (median) team member in the current sample was an enlisted sailor with a rank of E5, approximately three years of Navy experience, less than one year of assignment to NGFS duties, no formal NGFS training, and relatively little prior practice of NGFS duties. These data further suggest that a considerable percentage of the team members assigned to training at the NGFS school enter training with less than adequate NGFS skills and background.

INDICES OF TEAM PERFORMANCE

Graded Exercises

The relative success of teams in training was formally assessed by the instructors during the midterm and final phases of training. These phases consist of standard simulator exercises in which overall team performance is graded by the instructor according to a prescribed scoring protocol (a summary of the scoring procedure is given in Appendix H). The maximum possible score on these exercises is 100 points, and the minimum passing score is 70. Thus, the midterm and final scores provide relatively objective assessments of team performance near the midpoint and at the end of training. These scores are reported in Table 2 for each of the 13 teams.

These data indicate that the teams' performance scores generally increased from the midterm (M = 78.62) to the final (M = 86.92) phases of training ($t(24) = 2.22$, $p<.01$). This is taken as evidence of the general efficacy of the training experience. It should be noted, however, that for a given team the midterm and final performances were evaluated by the same instructor. Thus it is possible that the indicated increase in scores is the result of an instructor bias toward showing the improvement in performance. This seems to be refuted in the current case by the fact that the midterm and final scores were not significantly correlated ($r(13) = .46$, $p>.05$). As shown in Table 2, almost the complete range of possible scores was employed in both data sets, and for three teams the scores actually decreased from the midterm to the final. Thus, there is no evidence of bias in the reported scores. It should be noted, however that the average final examination score of 86.92 leaves considerable room for improving the overall impact of training on the final performances of NGFS teams.

The midterm and final examination scores were correlated with scores from the qualification exercises on the live-fire range. At the completion of the current research eight of the thirteen sample teams had completed their live firing exercises. For this subset of eight teams, performances on the final

Table 2

Midterm and Final Examination Scores for Each Team

Ship Number	Midterm Score	Final Score
1	86	90
2	97	87
3	83	98
4	70	96
5	70	78
6	92	94
7	69	70
8	78	88
9	70	78
10	70	80
11	70	89
12	95	91
13	72	91
Average Score	78.62	86.92

examination were significantly correlated with the live-fire qualification scores ($r(8) = .75$, $p<.05$). This suggests that by the time of the final phase of training, teams have acquired behaviors that are predictive of later performance during live firing. It should be noted, however, that in the current subsample of eight ships, the midterm exam scores were not significantly correlated with the performance scores from the range ($r(8) = .47$, $p>.05$). This suggests that the behaviors that are critical for successful performance on the range have not been acquired by the midterm phase of training.

Having established that the teams' final examination scores are a valid representation of performance in the field, the final scores were used as a criterion for dividing the teams into groups containing the more effective, medium effective, and less effective teams. These divisions were then used in order to analyze subsequent data sets for discrimination effects. The three groups of final examination scores are presented in order of performance proficiency in Table 3.

Based on the natural groupings of the 13 scores, three teams (3, 4, and 6) with scores of 94 to 98 were placed into the more effective category, and six teams (1, 2, 8, 11, 12, and 13) with scores of 87 to 91 were categorized in the effective set. The remaining four teams (5, 7, 9, and 10) with scores of 70 to 80

comprise the less effective set. In terms of these scores, the final performances of the effective teams differed significantly from both the more effective ($t(7) = 5.53$, $p<.001$) and the less effective ($t(8) = 6.59$, $p<.001$) teams. It should be noted that all of the teams in the sample successfully completed training. Therefore, some restriction in the range of scores is imposed on the data presented in the sections to follow.

Table 3

Final Examination Scores for NGFS Teams

Performance Category	Ship Number	Final Score	Category Mean
More Effective	3	98	
	4	96	96.0
	6	94	
Effective	12	91	
	13	91	
	1	90	89.3
	11	89	
	8	88	
	2	87	
Less Effective	10	80	
	5	78	
	9	78	76.5
	7	70	

Performance Ratings

The performances of the teams were also assessed by (a) having the instructor of each team to rate the overall performance of the team (using the Overall Team Performance Form) and the individual performance levels of each team member (using the Instructor Individual Performance Summary Form), and (b) requiring the team's leader (the Gunnery Liaison Officer; GLO) to rate the performance of all team members except himself (using the GLO Individual Performance Summary Form). The individual performance ratings were averaged across team members within each phase of training in order to produce a mean performance rating for each team in each phase. These data are compared to the instructors' overall performance ratings in Figure 5. In this and subsequent graphs of rating scale data, the obtained values have been subtracted from 5.0 in order to reverse the scale. Thus 4.0 represents the highest performance and 1.0 the lowest.

The data in Figure 5 indicate that the ratings made by both the instructors and GLOs generally increased across the phases of training. That is, both individual and overall team performances were judged to have improved. This finding provides further evidence of the general efficacy of the training exercises. The data of Figure 5 also indicate that the GLO tended to rate the performances of his team members higher than did the instructors. Correlations among the ratings within phases indicate that the GLO's ratings of individual performances were significantly correlated with the instructors' ratings of individual and team performances only during the midterm ($r(13) = .61$, $p<.05$ and $r(13) = .59$, $p<.05$, respectively) and final phases of training ($r(13) = .61$, $p<.05$ and $r(13) = .57$, $p<.05$, respectively). On the other hand, the instructors' ratings of individual performance were significantly correlated with their overall performance ratings within each phase. Similarly, correlations across phases indicate that pairs of ratings by the instructor were almost always significantly correlated. However, ratings by the GLO were almost never significantly correlated with either of the instructors' ratings. Thus, as would be expected, the two sets of ratings by the instructor are more consistently related to each other than to the ratings by the GLO. Only when objective test scores were available, in the midterm and final phases, were the three sets of ratings in relative agreement.

Figure 5 also shows that the instructors' overall ratings of the teams were the lowest of the ratings. This suggests that individual team members were seen as performing better than the team as a whole. However, this finding probably resulted from the fact that the instructor was more reluctant to assign poor ratings to a specific individual (where direct responsibility and accountability accrue) than to the overall team (where responsibility and accountability are dispersed).

When averaged across the training phases for each team, the instructor and GLO ratings were found to be significantly intercorrelated. These correlations were computed by averaging each set of ratings across phases and intercorrelating (across the 13 teams) the resulting mean individual and overall team performance ratings. As shown in Table 4, each set of mean ratings was significantly related to the other two sets of ratings. Of course, the instructors' overall and individual performance ratings were most highly correlated ($r(13) = .91$, $p<.05$). This pattern of intercorrelations indicates that a team's average evaluation was relatively the same regardless of the source of the evaluation, and this provides some evidence of convergent validity for the various scales. It should be noted that only the instructors' ratings were significantly related to mean scores on the midterm examination ($r(13) = .48$, $p<.05$ and $r(13) = .48$, $p<.05$ for the ratings of individual performance and team performance, respectively), and that none of the mean ratings were significantly correlated with performance during the final exam phase of training.

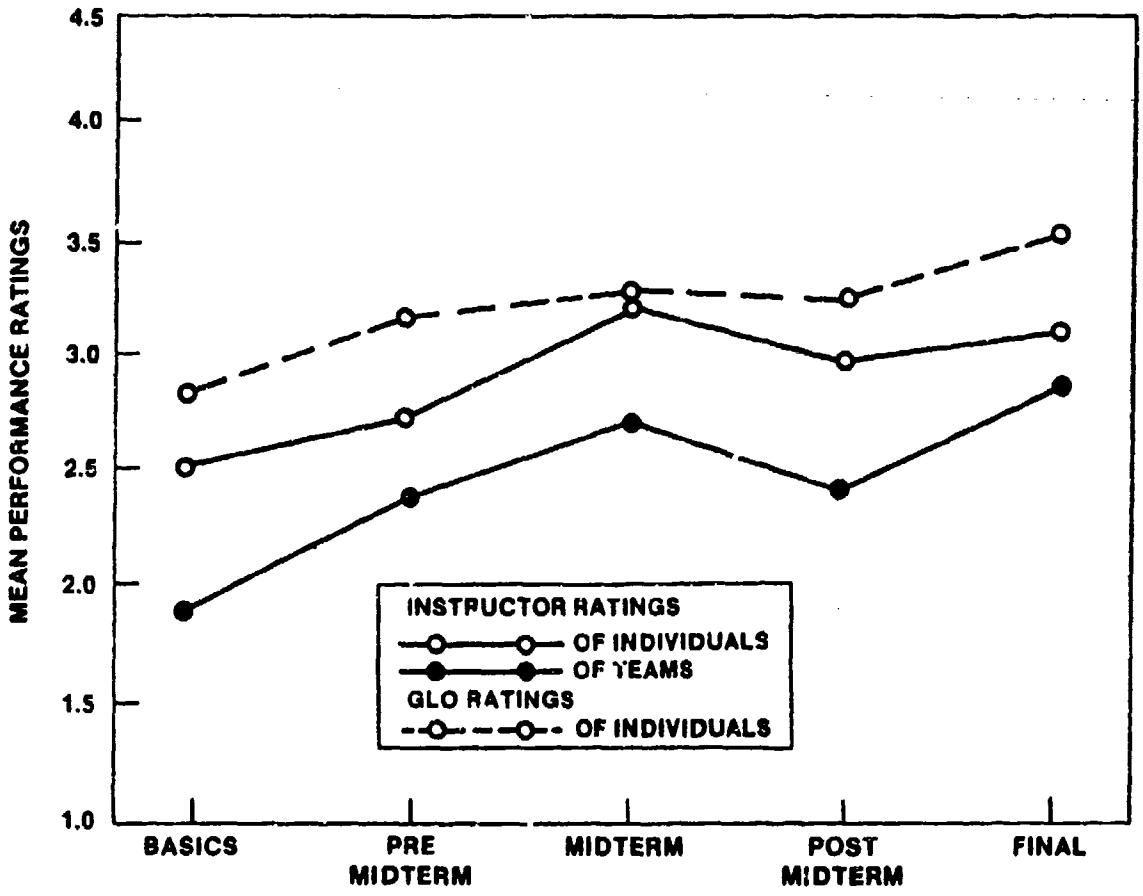


Figure 5. Mean ratings by the Gunnery Liaison Officer and Instructor of individual team-member performances and mean Instructor ratings of overall team performance for each phase of training.

Table 4

Intercorrelations of Mean Performance Ratings by the Instructor and the Gunnery Liaison Officer (GLO)

Rater/ Rating	Instructor Individual Performance	Instructor/Overall Team Performance
Instructor/Individual Performance	---	.91*
GLO/Individual Performance	.56*	.49*

n = 13 for both groups.
* $p<.05$.

The performance ratings for the more effective, effective, and less effective groups of teams are shown in Figure 6. In general, the ratings are somewhat higher for the more effective teams, but these differences are not large. The major differences in these patterns of ratings are seen in the facts that (a) the instructors rated the midterm and final performances of the more effective teams relatively highly, suggesting that they felt that these teams (in contrast to the other two groups) performed better in these "evaluation" phases than in the other phases; and (b) the instructors rated the overall performances of the most effective teams higher, or nearly as high, as the average individual performances of the members of these teams. This latter point clearly suggests that the teamwork skills of these teams were better that those of the other groups of teams--so much better, in fact, that in three phases the overall performance of these teams was judged to be better than the performance of the average individual team member.

In order to examine the relative performances of individual team members, each team member's performance ratings by the instructor and the GLO were averaged across the phases of training. These computations yielded the means and standard deviations presented in Table 5, which also presents the correlations between the instructor and GLO ratings of each individual's performance. These data indicate that when averaged across phases, the ratings (particularly those of the instructor) provide relatively small discriminations among the team members. Nevertheless, it is clear that both the instructor and the GLO placed the AGLO and CIC Supervisor positions among the highest-rated performers. Table 5 also indicates that the instructor and

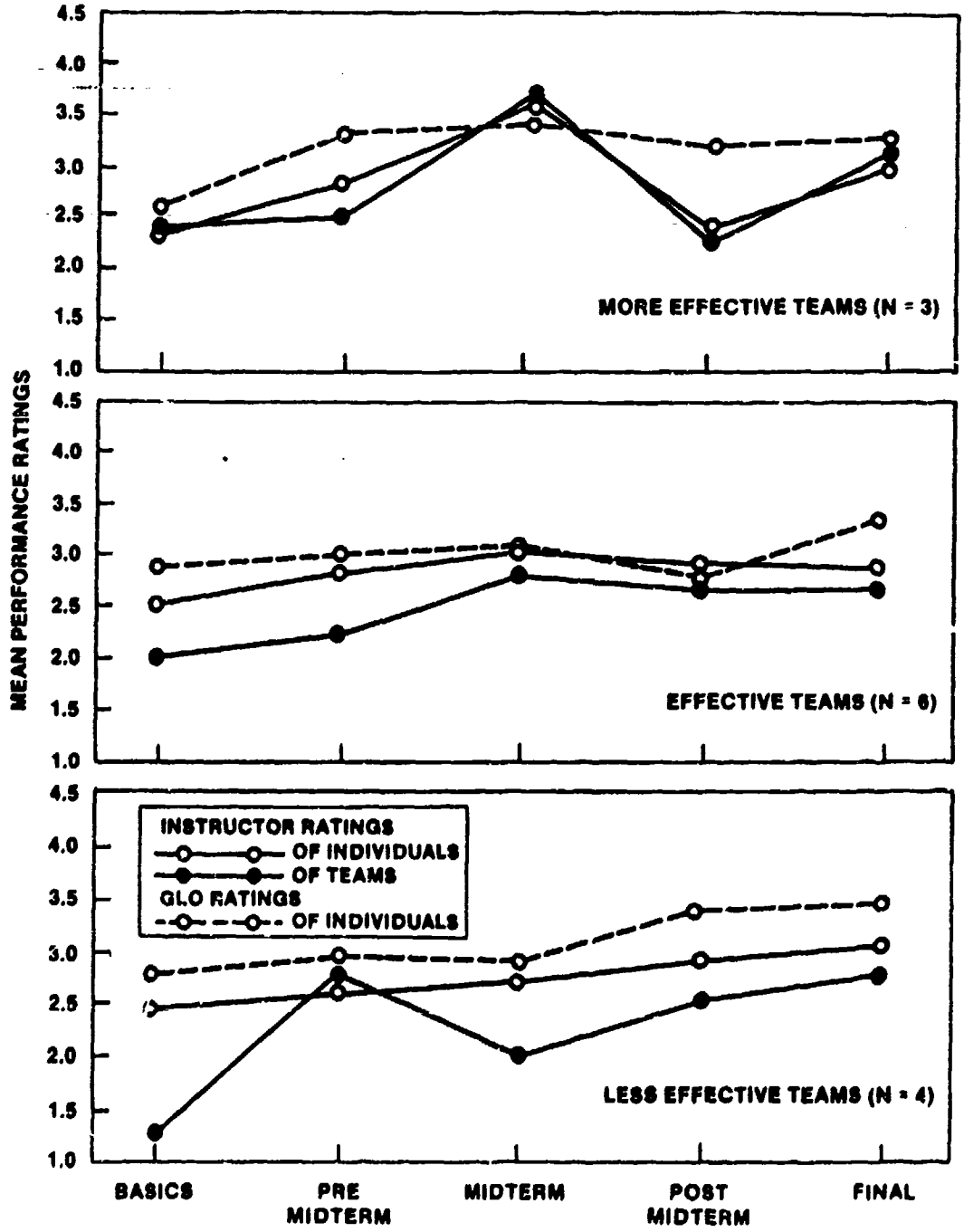


Figure 6. Mean ratings of individual (rated separately by the Gunnery Liaison Officer and Instructor) and team (rated by the Instructor) performance by phase for the more effective, effective, and less effective teams.

GLO ratings were significantly correlated for four of the team member positions. This means that the performances of the individuals in these positions were ranked in relatively the same order across the 13 teams by both the instructors and GLOs.

Table 5

Means, Standard Deviations, and Correlations of Individual Performance Ratings by the Instructor and the GLO

Position	Source of Ratings: Instructor	GLO	r
	Means (S.D.)	Means (S.D.)	
GLO	2.75 (0.83)	----------	
AGLO	2.99 (0.84)	3.34 (0.63)	0.64*
CIC Supervisor	2.96 (1.04)	3.17 (0.82)	0.67*
NAV Plotter	2.89 (1.06)	3.03 (0.74)	0.48*
Target Plotter	2.92 (0.99)	2.96 (0.87)	0.43
R/T Talker	2.69 (1.03)	3.20 (0.64)	0.31
R/T Recorder	2.67 (1.01)	3.12 (0.71)	0.64*
NAV Recorder	2.85 (0.85)	3.08 (0.71)	0.37

n = 13
* $p<.05$

The relative performances of the individuals who occupied the positions of the three major team leaders were examined by computing the instructors' average individual performance ratings for the GLO, AGLO, and CIC Supervisor for each phase of training. These data are shown in Figure 7 for the three more effective and four less effective teams. The ratings are somewhat higher for the more effective teams, and the patterns of ratings are different for the two groups. For the more effective teams, the GLO and AGLO are rated lower than the CIC Supervisor during basics, but their ratings rapidly improve to the point where their performances are rated considerably higher than that of the CIC Supervisor during the final phase. In the less effective teams, the ratings of the GLO are quite low (particularly during the three middle phases of training), and the ratings of CIC Supervisor improve during the course of training, but those of the GLO and AGLO do not. Thus, it appears that in the more effective teams the designated team leader (the

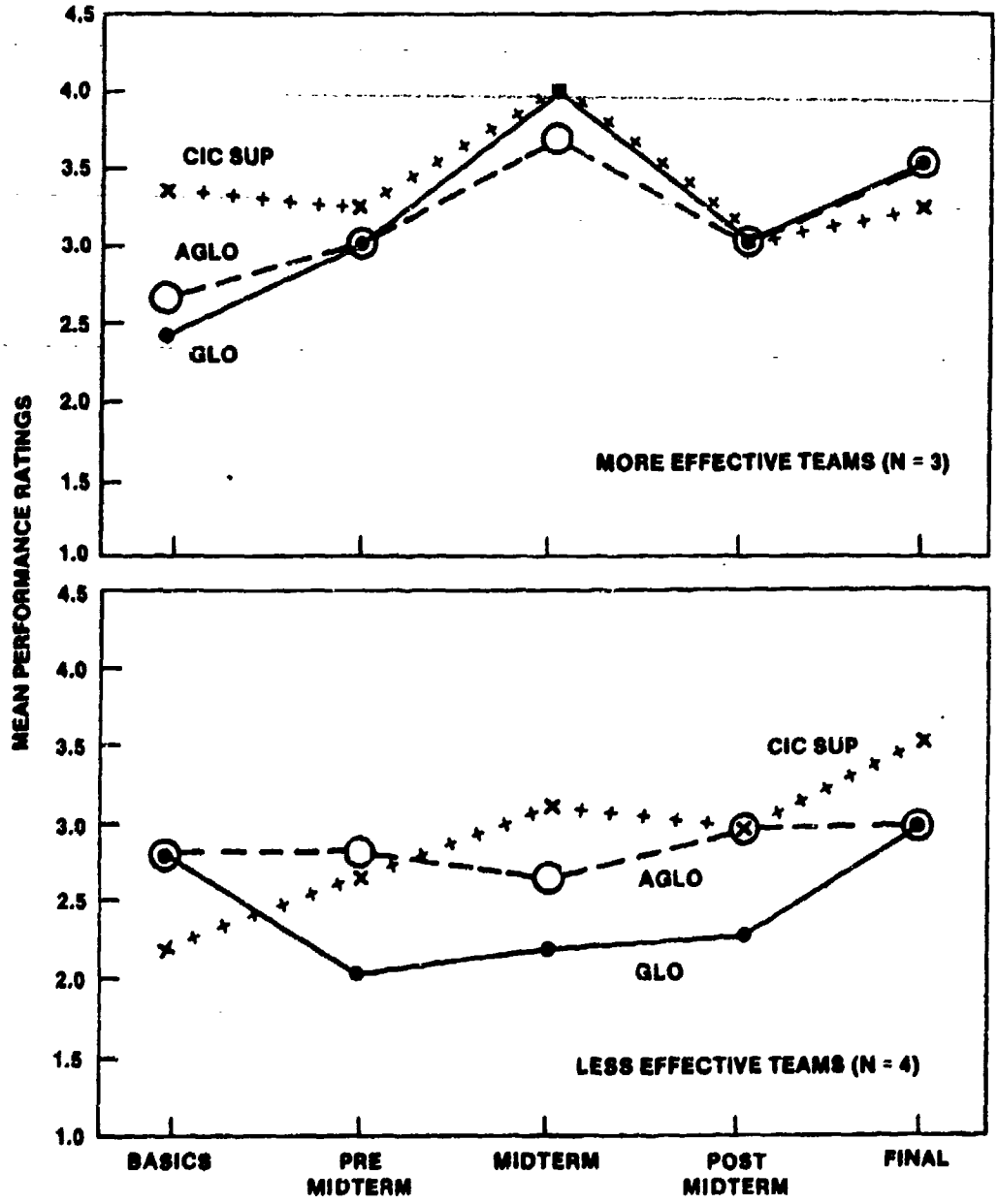


Figure 7. Means of the Instructors' ratings of the individual performances of the Gunnery Liaison Officer, Assistant Gunnery Officer, and CIC Supervisor by phase of training for the more and less effective teams.

GLO) adjusts to his role and provides effective leadership, whereas in the less effective teams the GLO fails to emerge as an effective leader. It seems that improvements in performance on the part of the less effective teams must be attributed in large part to the contributions of the CIC Supervisor.

CRITICAL TEAM BEHAVIORS

In completing the Critical Team Behaviors Form, the NGFS instructors reviewed lists of effective and ineffective behaviors for each of seven behavioral dimensions (communication, cooperation, team spirit and morale, giving suggestions or criticisms, coordination, accepting suggestions or criticisms, and adaptability) and for a category of infrequently occurring behaviors (see Appendix B for a copy of the Critical Team Behaviors Form). They marked the form so as to indicate which of the listed behaviors occurred during a just-completed training session. They also identified the initiator(s) and the recipient(s) of each reported behavior. Further discussion of the Critical Team Behaviors Form can be found in the Methods section and in Morgan et al. (1986).

Using the Critical Team Behaviors Form, the instructors recorded a total of 1102 critical behaviors for the 13 teams. Of these, 832 (75%) were effective behaviors and 270 (25%) were ineffective behaviors. It should be noted that the Critical Team Behaviors Form actually lists a total of 68 behaviors, of which 34 (50%) are effective and 34 (50%) are ineffective behaviors. Thus, there seems to be a decided tendency for instructors to record relatively more effective than ineffective critical events. Whether or not this literally mirrors actual events cannot be said at this time. The distributions of reports of effective and ineffective behaviors across and within phases are given in Table 6. These data indicate that the greatest proportion of behaviors occurred in the pre-midterm phase, but this is to be expected because a minimum of two administrations of the Critical Team Behaviors Form occurred during this phase.

As suggested above, the Critical Team Behaviors data were submitted to two lines of analysis. In the first, evolution and maturation effects were tested by examining the changes in team behaviors that occurred over the phases of training. In the second, discrimination effects were examined in terms of the behavioral differences that occurred in the more effective and less effective teams. In both of these cases, the behaviors of the individuals in the leadership positions of the teams (i.e., the GLO, AGLO, CIC supervisor, and instructor) were specifically analyzed in order to find the extent to which the leadership interactions reported here conformed to the expectations provided by the Component Model of NGFS Training (see Figure 3).

Table 6

Distributions of Effective and Ineffective Behaviors by Phase

Distribution	Training Phase					Totals
	Basic	Pre-Midterm	Midterm	Post-Midterm	Final	
Across Phases						
Effective	216 26.0%	273 32.8%	106 12.7%	146 17.5%	91 11.0%	832 100.0%
Ineffective	73 27.0%	107 39.6%	33 12.2%	37 13.8%	20 7.4%	270 100.0%
Total	289 26.2%	380 34.5%	139 12.6%	183 16.6%	111 10.1%	1102 100.0%
Within Phases						
Effective	216 74.7%	273 71.8%	106 76.3%	146 80.0%	91 82.0%	832 75.5%
Ineffective	73 25.3%	107 28.2%	33 23.7%	37 20.0%	20 18.0%	270 24.5%
Total	289 100.0%	380 100.0%	139 100.0%	183 100.0%	111 100.0%	1102 100.0%
Of Total Behaviors						
Effective	216 19.6%	273 24.8%	106 9.6%	146 13.2%	91 8.3%	832 75.5%
Ineffective	73 6.6%	107 9.7%	33 3.0%	37 3.4%	20 1.8%	270 24.5%
Total	289 26.2%	380 34.5%	139 12.6%	183 16.6%	111 10.1%	1102 100.0%

Evolution and Maturation Effects

The overall distributions of critical behaviors provide insights concerning the development of team behaviors during training. In terms of relative frequencies across phases (the upper panels of Table 6), the data indicate that the fewest behaviors were reported in the final phase and the next fewest in the midterm phase. This suggests that either (a) the evaluation exercises performed in these phases allowed relatively little opportunity for the occurrence of critical behaviors, or (b) the attention of instructors was concentrated upon scoring these test exercises, so that they failed to observe and report specific behaviors of the participants. Whatever the cause, the reporting of effective and ineffective behaviors seems to have been similarly affected across phases.

As shown in middle rows of Table 6, the percentages of behaviors occurring within phases indicate that the training resulted in a general improvement in performance. The relative percentages of effective behaviors increased and ineffective behaviors decreased substantially during the last three phases as compared to the first two phases. The parallel between this improvement in the relative proportion of effective/ineffective behaviors and the previously cited improvement in the indices of team performance adds weight to the inference that team performance was enhanced because teams learned to engage in effective behaviors more often, and to correct or eliminate ineffective behaviors.

This inference is illustrated further in Table 7, which compares the within-phase percentages of effective and ineffective behaviors in the first two and the last three phases for each of the dimensions represented in the Critical Team Behaviors Form. For example, 12.5% of the total number of Communication behaviors reported in the Basics and Pre-midterm phases were effective behaviors (87.5% were ineffective), while 16.4% of all behaviors in the midterm, post-midterm, and final phases were effective (83.6% were ineffective). Thus, performance in the Communication dimension improved in the latter phases in that a relatively greater percentage of reported behaviors were effective. (It should be noted that nearly 87% of the behaviors listed in the Communication dimension and the category of Infrequent Events were ineffective behaviors. Therefore, the percentages obtained within these categories are to be expected.)

Similar improvements in the relative occurrence of effective behaviors can be seen within most of the other behavioral dimensions. For example, for Accepting Suggestions, the relative percentage of effective behaviors increased from 70.6% (29.4% ineffective) prior to the midterm to 94.7% (5.3% ineffective) during and subsequent to the midterm. Closer examination of these responses in this dimension indicates that the improvement here

Table 7

Within-Phase Percentages of Effective and Ineffective Behaviors by Dimension for Combinations of the First Two and Last Three Phases

Dimension	Number (and Percentage) of Items Per Dimension	Phases Combined	
		Basic and Pre-Midterm	Midterm, Post-Midterm, and Final
Communication			
Effective	1 (14.3%)	12.5%	16.4%
Ineffective	6 (85.7%)	87.5%	83.6%
Cooperation			
Effective	6 (75.0%)	88.6%	94.7%
Ineffective	2 (25.0%)	11.3%	5.3%
Team Spirit & Morale			
Effective	7 (58.3%)	97.1%	92.6%
Ineffective	5 (41.7%)	2.9%	7.4%
Giving Suggestions			
Effective	5 (62.5%)	82.8%	88.9%
Ineffective	3 (37.5%)	17.2%	11.1%
Accepting Suggestions			
Effective	2 (33.3%)	70.6%	94.7%
Ineffective	4 (66.7%)	29.4%	5.3%
Coordination			
Effective	7 (63.6%)	79.1%	86.8%
Ineffective	4 (36.4%)	20.9%	13.2%
Adaptability			
Effective	5 (62.5%)	81.3%	81.3%
Ineffective	3 (37.5%)	18.7%	18.7%
Infrequent Events			
Effective	1 (12.5%)	13.3%	14.3%
Ineffective	7 (87.5%)	86.7%	85.7%

resulted primarily from reports of effective and more effective team members thanking other team members for catching their errors.

Overall, these data indicate that the manifestations of good teamwork skills increased with training in the dimensions of Communication, Cooperation, Giving Suggestions, Accepting Suggestions, and Coordination. Such improvement is not seen, however, in the data for Team Spirit and Morale, and for Adaptability, or the category of Infrequent Events. In the cases of the Adaptability dimension and the category of Infrequent Events, there was no real change in the relative percentage of effective behaviors across phases. However, in contrast to the pattern exhibited by the other dimensions, the relative percentage of effective behaviors decreased slightly across phases in the Team Spirit and Morale dimension. Closer examination of the data indicates that these percentages are based on very small numbers of behaviors and that they resulted from the fact that in the later phases of training members of less effective teams argued among themselves and made negative comments about the team or training.

Another evolution and maturation effect was examined by taking note of the extent to which the instructor and the team leaders (i.e., the GLO, AGLO, and CIC Supervisor) were involved in the activities of the team during the various phases of training. These results are particularly interesting with respect to the involvement of the instructor. Based of the Component Model of NGFS team development (see Figure 3), it was predicted that the instructor would be heavily involved in the teams' activities during the early phases of training and that he would withdraw himself from the team in later phases of training. This prediction is addressed in Table 8, which presents (for each phase) the number of recorded interactions in which the instructor was the initiator or recipient of a critical behavior.

These frequencies clearly show that the instructor actively participated with the team during the basics and pre-midterm phases, but that his participation decreased dramatically following the pre-midterm phase. These data strongly support the notion that most instruction takes place early in training and that the team is put "on its own" to a large extent after the first two phases. This is particularly evidenced by the frequencies with which the instructors initiated behaviors toward team members. As the table shows, the instructor initiated only two behaviors during the last three phases of training. Thus, one index of team development is the extent to which it continues to be necessary for the instructor to be actively involved in the team's activities.

Table 8

Number of Instructor-Related Behaviors by Phase

Instructor's Role	Phase					Total
	Basic	Pre-Midterm	Midterm	Post-Midterm	Final	
Initiator	14	28	1	1	0	44
Recipient	38	41	4	21	1	105
Total	52	69	5	22	1	149

Discrimination Effects

The Critical Team Behaviors data were also analyzed to uncover differences between the more effective and the less effective teams. These differences are reflected in Table 9, which provides for each phase and each dimension on the Critical Team Behaviors Form the number of effective and ineffective behaviors displayed by the more effective and less effective teams. It should be noted that there were three more effective teams and four less effective teams, however, because of uncontrollable circumstances data were collected for only three of the less effective teams during the postmidterm phase and two of them during the final phase of training. The means for the less effective teams (the rightmost column) were computed on the basis of the actual number of data points available.

The totals in Table 9 show, that the teams differed only slightly in terms of the number of ineffective behaviors (overall, both groups averaged approximately 25 ineffective behaviors per team). The major difference between the effective and ineffective teams is in the proportion of effective behaviors exhibited; the more effective teams averaged 66% more effective behaviors (93 per team) than the ineffective teams (about 56 per team). Thus, for the more effective teams, approximately 79% of the reported behaviors were effective (21% were ineffective), whereas for the less effective teams, only about 68% of the total behaviors were effective behaviors. This suggests that successful team performance is more dependent on learning which effective behaviors to perform than which ineffective behaviors to avoid.

These data must be interpreted in light of the reported differences in instructor's perceptions of and responses to teams with "good" attitudes and teams with "poor" attitudes, as

Table 9

Effective and Ineffective Behaviors by Dimension and Phase for the More Effective and Less Effective Teams

	Phase													
Dimension	Basics		Pre-Mid term		Mid term		Post-Mid term		Final		Total		Mean	
	ME	LE	ME	LE	ME	LE	ME	LE	ME	LE	ME	LE	ME	LE
Number of teams	3	4	3	4	3	4	3	3	3	2	15	17	3.00	3.40
Communication														
Effective	3	0	4	2	1	1	3	1	1	0	12	4	4.00	1.18
Ineffective	9	9	16	16	7	6	2	6	3	2	37	39	2.33	11.47
Cooperation														
Effective	12	15	22	17	9	3	9	14	7	2	59	51	19.67	15.00
Ineffective	2	3	2	1	0	2	0	1	0	0	4	7	1.33	2.09
Team Spirit & Morale														
Effective	11	14	23	13	7	2	8	3	7	5	56	37	18.67	10.88
Ineffective	0	0	1	0	0	2	0	0	0	2	1	4	0.33	1.18
Giving Suggestions														
Effective	7	6	13	8	4	2	6	5	3	0	33	21	11.00	6.18
Ineffective	2	0	2	3	0	1	0	0	0	0	4	4	1.33	1.18
Accepting Suggestions														
Effective	4	3	6	2	2	0	2	0	4	0	18	5	6.00	1.47
Ineffective	1	0	1	3	0	0	0	0	0	0	2	3	0.67	0.88
Coordination														
Effective	12	19	26	12	10	2	9	11	10	5	67	49	22.33	14.41
Ineffective	3	4	4	7	0	1	1	3	1	1	9	16	3.00	4.71
Adaptability														
Effective	6	6	15	11	5	0	5	5	3	1	34	23	11.33	6.76
Ineffective	3	2	3	5	1	0	0	1	2	0	9	8	3.00	2.35
Infrequent Events														
Effective	0	1	0	0	0	0	0	0	0	0	0	1	0.00	0.29
Ineffective	5	2	2	3	0	0	0	1	2	0	9	6	3.00	1.76
Total														
Effective	55	64	109	65	38	10	42	39	35	13	279	191	93.00	56.18
Ineffective	25	20	31	38	8	12	3	12	8	5	75	87	25.00	25.59

discussed in Guerette et al. (1987). It is possible that although the instructors find the same level of errors (indicated here by ineffective behaviors), perhaps the instructors "look for" more positives (indicated here by effective behaviors) from the teams with "good" attitudes that perform at a higher level. Or the differences might be more simply explained by assuming that the higher performers outperform the less effective teams because they have available a greater number of effective behaviors. Only additional research can clarify the inferences to be made.

Another discrimination effect in the Critical Team Behaviors data involved the information flow to and from the GLO (team leader) in the more effective and less effective teams. The data relevant to this finding are presented in Table 10. This table reports by phase, and separately for the more effective and less effective teams, the frequencies and within-phase percentages of behaviors for which the GLO was an initiator or recipient of action.

Table 10

Percentages of Behaviors by Phase for the GLO of More Effective and Less Effective Teams

GLO's Role	Phase				
	Basics	Pre-Midterm	Midterm	Post-Midterm	Final
More Effective Teams (N = 3)					
Initiator	22	20	14	8	6
	52.4%	39.2%	87.5%	36.4%	50.0%
Recipient	20	31	2	14	6
	47.6%	60.8%	12.5%	63.6%	50.0%
Total	42	51	16	22	12
	100.0%	100.0%	100.0%	100.0%	100.0%
Less Effective Teams (N = 4)					
Initiator	38	33	10	20	3
	70.4%	68.8%	62.5%	66.7%	50.0%
Recipient	16	15	6	10	3
	29.6%	31.2%	37.5%	33.3%	50.0%
Total	54	48	16	30	6
	100.0%	100.0%	100.0%	100.0%	100.0%

These data indicate that there was a differential pattern of information flow for the more effective and less effective teams. In the less effective teams, information tended to flow from the GLO to the other team members. On average, a GLO in these teams initiated about 68% of all the behaviors in which he was involved. This suggests that the leaders of these teams perceived a need to initiate actions to compensate for the deficiencies of other team members, and that they adopted a more active, directive form of leadership. In the more effective teams, the leadership pattern seems to be more relaxed, particularly in the three "learning" phases of training, Basics, Pre-midterm, and Post-midterm. On average, a GLO in these teams initiated only 49% of the behaviors in which he was involved. This suggests that these team members more often "carry their own load" during performance so that the GLO is not required to initiate most of the action. During the midterm, however, the effective GLOs seem to take control and become much more active participants in performance. In addition, the overall pattern of interaction seems to be disrupted during the final phase when information flows equally in both directions for both groups of teams. These important differences in information flow might have important implications concerning the effectiveness of different types leadership.

SELF-REPORT QUESTIONNAIRE

The analysis of the Trainee Self-Report Questionnaire began with 105 data points for each of the 117 individuals in the current sample (21 questionnaire items for each of the five phases of training). Estimates of the within-phase reliability of the questionnaire were obtained by computing Coefficient Alpha (Nunnally, 1978) for each phase of training. These estimates are given in Table 11. Although the questionnaire was not designed to provide samples within a single response domain, the magnitude of the obtained coefficients indicates that the instrument did achieve acceptable levels of internal consistency.

Although the questionnaire items exhibit reasonable levels of consistency within each phase, the responses to the items should be expected to undergo changes across the phases of training. As training proceeds, job skills are acquired, team interaction patterns are established, lessons learned interact and aggregate, and perceptions are transformed. These experiences should produce changes in one's view of the team and his understanding of the questionnaire items. In turn, these changes should alter the pattern of intercorrelations among the items. Thus, the 21 items cannot be expected to be constant, discrete, and independent measures. Nevertheless, a "lower-limit" estimate of test-retest reliability was obtained by computing the correlation between the responses from the first two administrations of the questionnaire (without respect to phase). This procedure yielded a reliability coefficient of 0.64 for the

total score on the questionnaire. While this estimate must be interpreted with considerable caution, it also suggests that the instrument has acceptable psychometric properties.

Table 11

Coefficients Alpha for the Self-Report Questionnaire by Phase

Phase	Coefficient Alpha
1	0.81
2	0.86
3	0.86
4	0.89
5	0.87

Factor Analysis

The questionnaire data were submitted to a series of exploratory factor analyses designed to determine the extent to which the factor structure of questionnaire responses changed as a function of training. It was reasoned that the changing patterns of item intercorrelations over time would be reflected in changes in the number and the contents of factors that emerged at each of the five phases of training, in the changes in item loadings on the factors, and by shifts in the proportion of variance accounted for by the factors that emerged at different phases. The use of factor analysis was also deemed appropriate because it would help to (a) reduce the number of variables to be manipulated statistically and cognitively; (b) increase the reliability of measurement by increasing the number of items incorporated into a given measure; and (c) provide a meaningful explanation of the evolution of teamwork based on the interpretations of factor structures. The classic analog for studies of this sort is Fleishman and Hempel's (1955) work on changes in psychomotor skill factor structure with practice.

The factor analyses (principal axis) began with a matrix of intercorrelations containing all of the items from all of the phases (the total 105 possible data points). This overall

analysis of the total data set resulted in a factor structure with five factors, each of which contained the responses obtained during one of the five phases of training (thus, a different factor represented each phase of training). This was interpreted to mean that the team members perceived the team differently in each of the phases. This provided evidence that "something" in the situation changes from one phase to another, that this change is detected by the team members, and that this changing perception is reflected in their responses.

This overall factor analysis, however, provided little insight into the nature of the changes in perceptions during training. Therefore, a series of factor analyses was conducted in which the data from adjacent phases were combined (Basics with Premidterm, Premidterm with Midterm, and so forth) and a seperate factor analysis was made of each set of combined data. This approach was successful in providing a basis for interpreting the changes in team members' perceptions from one phase to another during the course of training.

These analyses generated three primary factors, which have been designated as a "teamwork" factor, a "taskwork" factor, and a "jelling" factor. (For a more detailed description of the factor analysis results, see Appendix I). The teamwork and taskwork factors appear to correspond to the two activity tracks of the TEAM model (see Figure 2). As anticipated by the TEAM model, these factors, which are separate and distinct at the beginning of training, merge into a single factor later in training. The jelling factor emerges during the later phases (midterm and final). These results provide empirical support for the general concepts embodied in the TEAM model.

Profiles of Perceptions

After the teamwork, taskwork and jelling factors had been identified, factor scores were developed to represent each factor and phase. These scores were based on factor keys, which were designated to include those items that were most common to the respective factors across phases. (See Appendix I for a fuller explanation of the factor scores and their development). Thus, items 5, 9, 12, 18, 19 and 21 constituted the teamwork factor key; items 4, 10, 11, 17 and 20 constituted the taskwork factor key; and items 2, 3, and 8 formed the jelling factor key. (See Appendix F for the contents of self-report items). The factors were used to obtain scores for each phase by summing the weights for the individual items that make up each factor key. Table 12 presents the mean factor scores by phase for the teams in the sample.

These factor scores can be compared across phases, but not with each other, because different numbers of items make up each of the keys. An examination of the factor scores for evolution

and maturation effects, indicates that the maximum score occurred in the midterm phase for each of the factors. This testing phase is the first and most significant hurdle in the successful completion of the training, and it would appear that the teams are perceived by their members as "rising to the occasion" with maximal teamwork, taskwork, and jelling efforts. It should be noted that virtually all teams that successfully pass the midterm go on to complete the training course successfully.

Table 12

Mean Factor Scores for Each Phase of Training

	Factor Identification		
Training Phase	Teamwork	Taskwork	Jelling
Basics	23.72	17.52	12.53
Pre-Midterm	24.65	18.29	12.54
Midterm	25.02	18.69	12.70
Post-Midterm	24.74	18.39	12.32
Final	24.45	17.31	12.48

THIS PAGE INTENTIONALLY LEFT BLANK.

DISCUSSION

OVERVIEW OF FINDINGS

This section will focus on the empirical findings that appear to contribute most to the understanding of how Naval teams develop and the processes by which teamwork skills evolve and mature. Whenever appropriate, in order to add insight concerning the nature of the phenomena, illustrations will also be drawn from experiences obtained during the course of developing the procedures used in data collection and analysis.

In the next and final section, special attention will be given to a number of possible applications of these findings that might be incorporated into the design of training systems and instructional techniques. As indicated earlier, the ultimate goal of this programmatic research effort is the generation of such innovations and their evaluation against the criteria of utility and training effectiveness. It should be noted that similar studies are being conducted under the present program at Anti-Submarine Warfare (ASW) and Guided Missile Training (GMS) installations. These subsequent investigations are designed to extend the range of situations covered, enable comparisons to be made, suggest additional potential innovations, and provide inferences as to the generalizability of the findings and the operational applicability of recommended innovations. It should also be noted that some recent changes in the NGFS curriculum have moved in the directions indicated here.

The current discussion will be divided into three parts. The first part will deal with findings related to the conceptual framework around which the NGFS study was originally organized. Highlights of the findings concerned with the research's theoretical concepts may be summarized as follows:

1. Analyses of the data obtained from the Critical Team Behaviors Form and the Trainee Self-Report Questionnaire support the notion that teams do progress through distinguishable stages of development.

2. A relatively larger number of effective behaviors were reported for the more effective teams than for less effective teams. Teams were approximately equal in terms of ineffective behaviors.

3. Factor analysis of the Trainee Self-Report data identified the presence of a teamwork factor and a taskwork factor. This suggests that these components of training are independent and that sound instructional design should specifically address each one.

4. Factor analysis of these data indicated that teamwork was more salient during the early phases of training and that taskwork gained prominence thereafter. This suggests that teamwork skills such as cooperation and coordination should be stressed during the early stages of training.

5. During the later stages of development, the teamwork and taskwork factors converged, suggesting that optimal performance requires attention to both team and task factors. This confirms the importance of maintaining a focus on training for teamwork, in addition to a task focus, in order for the team to become effective.

6. Greater cohesiveness, as evidenced by the "jelling" factor was noted during the testing phases. It is possible that the imposition of an external demand serves as a facilitator, and that the introduction of measurable goals at an earlier period might expedite the development of cohesion within a team.

The second part of this discussion will deal with the technical and methodological aspects of the data collection, measurement, and analysis techniques employed in the research. This discussion of technological and methodological matters will focus on the following point:

1. The Critical Team Behaviors Form, which provides a record of observed trainee behaviors as perceived by the instructors, was found to be sensitive to differences in team performance.

The third part of this discussion will focus on the implications of the current findings for improving instructional methods. Highlights of these implications include the following:

1. Individual training is necessary, but not sufficient for effective team performance. This is supported by results of the factor analyses which suggest that it would be beneficial to focus on teamwork skills such as cooperation and coordination before emphasizing task-oriented skills. Thereafter, integration of the two types of skills should be stressed.

2. Unexpected, non-routine events should be incorporated into training programs in order to emphasize the need for teamwork.

3. The imposition of external demands along with measures of goal and subgoal achievement might expedite the development of cohesion within teams.

4. Behavioral standards identified by findings from the Critical Team Behaviors Form should serve as performance benchmarks for goal-setting and for evaluating the performance of teams.

5. Comparisons of the overall performance ratings of the team with the individual performance ratings enables the identification of "critical positions," in which deficiencies on the part of the incumbents may not be counteracted by additional effort by other team members.

6. The formal leader of the team, the GLO, appears to occupy a "critical position," and this position might benefit from supplemental training in team performance concepts such as communication, cooperation, and coordination.

7. The implications from this research should be incorporated into a training program to enhance the instructors' understanding of the developmental process of teams. This understanding could facilitate the development of realistically higher expectations concerning team performance at different stages of development. Furthermore, training on the use of the Critical Team Behaviors Form could enhance its utility as a basis for diagnosis and providing specific feedback.

CONCEPTUAL FRAMEWORK FOR IMPROVING TRAINING

The driving force behind this research has been the search for ways to improve team training. Such efforts necessitate a conceptualization of the developmental processes through which teamwork evolves. Such a framework provides direction and facilitates the systematic exploration and evaluation of alternative interventions. As stated at the outset, a failing of earlier team training research has been the lack of attention to the process through which teamwork skills such as communication and cooperation are learned (Dyer, 1984; Morgan et al., 1986).

Conceptual efforts related to the present research have been focused on two major objectives: (1) the description of changes in the processes evidenced in teams undergoing training; and (2) the identification of interventions that might expedite and enhance the development of teams. Therefore, this section begins with a projection of the current findings against developmental models depicting the change processes. These findings are then discussed in terms of their implications for improving training.

Efforts to understand how teams evolve under the present system of training have focused on identifying the changes in team behaviors that were observed and recorded by the instructors (using the Critical Team Behaviors Form) and reported by the team

members (using the Trainee Self-Report Questionnaire). Both sources of data reflect changes over time and provided support for the developmental models described in the following paragraphs.

Three models have been developed during the course of this research program. The Generalized Model of Team Evolution and Maturation (see Figure 2) and the Stage Model of Naval Gunfire Support Training (see Figure 4) address the stages through which teams progress during the course of training. The Component Model of NGFS Training (Figure 3) describes how instructors involve themselves as a "member" of the team, then withdraw from that role in order to serve as an outside resource and transfer "ownership" of the training process to the team (see Figure 3). The following sections will relate findings from NGFS to the Stage Model of Naval Gunfire Support Training. Thereafter, data supporting the Component Model of NGFS training will be discussed.

Stage Model of Naval Gunfire Support Training

A major question addressed by this investigation has been whether or not teams progress through identifiable stages of development during training. The results of this investigation indicate that such a progression can be identified. This holds implications for the sequencing of training, because the sequence of training activities should parallel and enhance the development of teams. For instance, it would be unrealistic to expect that team members would be able to work together optimally without first recognizing and understanding the nature of their interdependencies.

Data from the Trainee Self-Report Questionnaire provided support for the Stage Model of Naval Gunfire Support training. Factor analyses of these data have revealed the presence of both a teamwork factor and a taskwork factor. The former reflects an orientation toward the development of team interactions and the latter indicates an orientation toward the specific requirements of the team's technical tasks. As training progressed, these two factors converged. Both the presence of the two factors and their convergence over time parallel expectations based on the TEAM model (Morgan et al., 1986).

Thus, these findings confirm the existence of developmental stages and provide information concerning the nature of the changes that take place over time. Information of this nature has implications for the training of instructors, many of whom possess strong technical backgrounds and general instructional training, but have had little formal exposure to teamwork concepts. Applications of these findings could be assimilated into instructional training aids to increase awareness of the importance of team skills, and to demonstrate that optimal

performance requires proficiency in both teamwork and taskwork components. One possible way to emphasize the crucial nature of teamwork for team members and instructors alike, is to incorporate unexpected, non-routine events into the training procedures.

A third factor, referred to as the "jelling" factor, emerged during the two "testing" phases of training. This factor reflects group cohesiveness, and it is possible that the introduction of an external demand, the tests, promoted its emergence. Analysis of the data collected at ASW, which provides only one test on the final day of training should help to clarify whether this factor is influenced by the imposition of an external demand. Evidence supporting the latter explanation would argue for the implementation of explicit goals and subgoals at earlier stages of development, perhaps on a daily or individual exercise basis. The inclusion of unexpected events might also serve to expedite the development of cohesion as well as promoting the convergence of teamwork and taskwork factors.

Component Model of NGFS Training

During the early stages of training, the instructor assumes a key role in the team. By providing direction to the team members, the instructor serves as a role model for the team leader, who will subsequently be expected to direct the team. As training progresses, it is necessary for the formal leader to assume greater responsibility for the performance of the team, while the instructor withdraws from the role of a team member to assume the role of an outside observer and facilitator. Initial interviews with the instructors suggested that this transition tended to occur around the time of the midterm. Data collected with the Critical Team Behaviors Form (see Table 8) revealed a sharp drop in the number of recorded behaviors involving the instructor after the pre-midterm phase. The instructor maintained a low level of direct involvement with the team in the last three phases.

IMPROVING INSTRUMENTS AND ANALYSES

This section discusses the procedures used in the analysis of the changing perceptions of the team members; i.e., the introduction of the factor analysis of overlapping sessions of data. Future directions for the analysis of the present data are also discussed. The Trainee Self-Report Questionnaire, which provided the responses for the overlapping sessions factor analysis, is also described and suggestions for modifications are offered. Next, attention is directed to the Critical Team Behaviors Form, which served as a record of instructor observations of the behaviors of team members. The potential utility of this instrument as a diagnostic tool for instructors

is discussed along with suggestions regarding its implementation. Finally, the use of the rating forms to assess individual performance in relation to the performance of the team as a whole is discussed.

Analytic Techniques

One of the most challenging aspects of this research was to develop analytic techniques that would provide a means of tracing the evolution and maturation of the teams in training. One of the most important results of these efforts was the development of the overlapping-sessions factor analyses which were used to analyze the responses to the Trainee Self-Report Questionnaire. This technique appears to be a unique application of factors analysis procedures (J. L. James, personal communication, June 8, 1987). No reference to this approach has been discovered in the literature. However, the current application does meet the proposed guidelines for exploratory factor analysis presented by Ford, MacCallum, and Tait (1986).

Beyond the analyses of the data recorded in this report, a continuing effort is in progress to analyze the current data in other ways. These new analyses have as one goal a method for linking the results of the different data sources together to portray the entire process in a multi-dimensional space, defined by the vector components of the different solutions of the individual data sets. As appropriate, the results of these additional analyses will be presented in an upcoming technical report.

Data Collection and Measurement Method

Two types of information were collected at NGFS. One type of data reflected the observations of the instructors, while the second type reflected the perceptions of the team members. The first type of information was collected using the Critical Team Behaviors Form, the Individual Performance Summary, and the Overall Performance Form. The second type of information was obtained from the Trainee Self-Report Questionnaire and the Individual Performance Summary completed by the Gunnery Liaison Officer (GLO).

Trainee Self-Report Questionnaire. Training that achieves the desired results requires not only increases in the number of effective behaviors, but also changes in the attitudes and perceptions of the trainees. In team training, it is necessary for the goals of the trainees to be transformed from an individual focus to a concern with the performance of the team as a whole. The Trainee Self-Report Questionnaire provides a reliable mechanism for tracking this change.

In subsequent versions of the questionnaire (e.g., for use at the ASW training site), sociometric measures involving the "most" and "least" valuable player on the team have been deleted. These items, particularly the latter, met with resistance and derision from the team members. Despite assurances of confidentiality, most of the respondents felt uncomfortable with these questions.

Critical Team Behaviors Form. Attempts to improve team training require the ability to distinguish between more and less effective teams. Analysis of the data provided by The Critical Team Behaviors Form indicates that this form (or variations thereof) might have potential as a diagnostic and debriefing tool. However, more formalized training of the instructors in the utilization of this form would certainly enhance its usefulness as such a tool. Training such as that provided to assessment center raters could be used to enhance the observation and coding skills of the instructors, necessary elements in the accurate recording of performance assets and deficiencies. Special videotapes of team performance could also be employed in conjunction with "master" Critical Team Behavior Forms, which would indicate which of the critical behaviors were displayed and by whom. Portions of the videotape could be replayed to highlight observation error. These approaches are particularly needed in order to deal with interpersonal behaviors which usually are not as easy to observe as the technical task components of behavior.

For practical purposes, it would be desirable to reduce the length of the Critical Team Behaviors Form. The demands for the broadest possible coverage of behaviors in the first round of research must give way to utilitarian concerns if more operational applications of this technique are to be implemented. Whereas the Overall Team Performance Form and the Individual Performance Summary could be completed in three to five minutes, the Critical Team Behaviors form often required up to 45 minutes. An obvious concern is that the quality of the data collected may suffer because of the time required for completion. To the extent that such errors exist, it is likely that they are errors of omission. The effects of such errors are difficult to predict. Since the scoring procedure traditionally used by the instructors during the midterm and final subtracts points from 100 when errors are made, however, it is not unreasonable to assume that the instructors become more sensitive to ineffective behaviors than effective ones. Therefore, a disproportionate number of effective behaviors might have been omitted. It is also possible, as a general proposition, that incidents of effective performance do not as readily elicit reactions from instructors or supervisors simply because they less often call for action by the observer (they are perceived as less critical incidents). Commonly this is rationalized as "If it isn't broken, don't fix it." Even so, it is the number of effective behaviors within each dimension that provides the distinction

between more and less effective teams; more so than the number of ineffective behaviors. Both effective and ineffective behaviors, however, do show potential for the identification of benchmark critical behaviors for purposes of discriminating between stages. A related innovation would be a device that makes it easier to record observations. Hand-held electronic devices exist for making entries of coded information. Some permit accumulated data to be transferred into computer files. It may be possible to devise such an aid to serve this purpose. This possibility is being explored.

As reported earlier, the number of recorded behaviors decreased sharply during the testing phases (i.e., the midterm and final). It is possible that the team members displayed fewer behaviors during these phases. However, a more likely explanation is that the performance criteria on which the teams were being tested were more salient to the instructors and that this diverted attention away from the observations required by the Critical Team Behaviors Form. As an alternative to collecting data during the testing phases, procedures have been established at subsequent sites (e.g., ASW) to allow data collection during the practice mission that immediately precedes testing. (Two or three such missions are typically included for each type of exercise.) In this way the quality of the data collected could be improved.

Other Instruments. An important consideration in team training is the extent to which extra effort on the part of some team members can compensate for the poorer performance of other members. The combined use of the Instructor Individual Performance Summary and the Overall Team Performance Form provides this information. Furthermore, the inclusion of the GLO Individual Performance Summary provides a means for assessing the ability of the formal leader to evaluate the effectiveness of individual members of his team. This ability becomes more essential when training takes place aboard ship, under the direction of ships' officers and petty officers.

As has been indicated, the ability of GLOs to judge the performance of their subordinates appeared to be inversely related to their effectiveness as formal leaders. It may be that the cognitive demands placed on the leader in effectively carrying out his role preclude accurate assessment. This being the case, it may be productive for ships engaging in shipboard training to provide an outside observer who is not a member of the formal team to assume the role of an evaluator.

The discussion in this section has been especially sensitive to situations that might be subject to improvement by one means or another. This may have had untoward consequences for the unwary reader, who might accentuate the negative. It would be a mistake to read this as an exercise in evaluating NGFS training.

Nearly all teams undergoing training at NGFS complete the training and meet the Navy's standards for operational readiness, and all of the current data came from ships that "passed" the training course. The aim here has been to find ways to make training better. Therefore, the discussion has focused on an effort to "look for trouble." We must call attention to the fact that the NGFS school has recently initiated a number of changes in the organization and content of its curriculum that move in the directions indicated here. The next phase of this research, will accentuate the positive as efforts are made to design and evaluate specific ways to raise the level of effectiveness of training for teams in schools and in ships. Some potential ways to accomplish this objective are discussed in the next section.

IMPROVING METHODS OF INSTRUCTION

It is difficult to suggest improvements in the training process without considering the role of the instructor, who provides the training. For this reason, the following discussion is concerned with ways to help the instructor to improve the quality of team training.

To begin with, it is obvious that instructional programs for team training should be able to adapt to differences in the needs of the trainees, and to changes that take place in teams over time. Further refinement and adaptations of information like that of the Critical Team Behaviors Form could provide the basis for this adaptability. That is, instructors could be trained to use this or similar instruments to identify deficits in teamwork skills, diagnose potential causes of poor performance, and develop standards of teamwork for each stage of training. Such information could be used by instructors to modify training regimens as necessary to address identified teamwork problems.

Although the central interest here is team training, the contribution that individual competencies make to the success of training cannot be ignored. Certain minimal levels appear to be prerequisite for effective team training, (Dyer, 1984; Hall and Rizzo, 1975; Johnston, 1966). For example, in the case of NGFS teams, the performance of the whole team may be most largely determined by the competencies of the Gunnery Liaison Officer (GLO). Current results indicate, however, that under certain circumstances other team members can compensate for weaknesses in the GLO. Thus, individual competence on the part of team members is a necessary, but not sufficient condition of effective team performance.

Finally, it should be noted that the training of the instructors represents the culmination of all other efforts to build better training systems. All that is learned about the effectiveness of any type of intervention must eventually be incorporated into the training of those people whose ultimate

responsibility it will be to teach teamwork skills. Such training should prepare the instructor to recognize, reinforce, and remedy deficiencies in teamwork skills.

Sequencing of Training

When planning a program of instruction for team training, it is necessary to consider the team's overall readiness for specific types of training. Factor analyses of the responses to the Trainee Self-Report Questionnaire have indicated a differential sensitivity to the teamwork and taskwork aspects of training across phases. During the initial phase of training, the teamwork factor accounted for the largest percentage of the variance. In the following phase, the taskwork factor accounted for a greater proportion of the variance. This shift in variance accounted for during the first half of training suggests a shift in the salience of each factor for the trainees. After the individual members were brought together as a team, the nature of their interdependencies became salient, and this cognizance then allowed the team to focus more fully on the activities related to technical task performance. For application to NGFS training, it is suggested that teamwork skills such as cooperation and coordination should be emphasized early in training (beginning with the Basics phase) when the team members are more sensitive to the interdependencies of their individual responsibilities. Later, when the focus shifts to taskwork factors, emphasis should be placed on developing the technical skills which promote task accomplishment. Further testing of this "critical period" hypothesis (e.g., Gersick, 1985) of development is still needed.

Expediting Evaluation

Constructs such as cooperation and cohesiveness are uniformly linked to effective team performance. Targeted efforts to expedite their emergence could, therefore, be useful in improving the quality of team performance in training. The factor analyses of the Trainee Self-Report Questionnaire responses suggests that this might be possible. The emergence of the "jelling" factor (see Table 11) during the midterm and final phases of training may very well reflect a feeling of group solidarity or cohesiveness that results when the team members see the "pieces--taskwork and teamwork--fall into place" as they respond to the requirements of collective effort and achievements called forth by the "test demands." The emergence of this factor at these points in time is consistent with the work of Gersick (1985). She suggested that problem solving groups tend to pull together at such times in order to satisfy external demands. It is possible that the daily administration of tests, or other direct indications of goal and subgoal requirements and achievements (a proposition presently being operationalized by NGFS management), might expedite the developmental process.

This might also explain the emergence of the taskwork factor as the team approached the midterm. In her research on problem-solving groups, Gersick found that groups undergo a transformation halfway through their lifecycle. At that time, groups re-evaluate their progress and refocus their energy toward completion of the task. Initially, it was assumed that this type of reformulation would occur at NGFS during the midterm. Subsequent evidence concerning the importance of satisfactory performance on the midterm, and the recognition that the bulk of the basic training material is presented during the first two phases of training, challenged this assumption. Rather, it might be that the team views the midterm (rather than the final)as the "real" test . That being the case, the reforming stage might be expected to occur during the pre-midterm phase. It is during the transition from the pre-midterm phase to the midterm phase that the taskwork factor emerges, a natural consequence of the reformulation and a precursor to the development of the "jelling" factor. Data to be collected later at the ASW training site may help to clarify whether the emergence of the "jelling" factor is the result of natural evolution and/or the product of an external demand. At ASW, the only formal test of team performance occurs on the final day of training.

Developing Standards

The identification of stages in the process of team motivations, and interventions which may speed this process, paves the way for the development of teamwork norms for teams at various performance levels. Greater attention needs to be directed toward the identification of specific changes in behavior which could serve as benchmarks in each stage of team development. For instance, such changes were identified in the behaviors recorded in the Communications dimension of the Critical Team Behaviors Form. During the initial stages of training, team members are frequently unsure about how they should interact. During the first day of training, one of the most frequently recorded ineffective behaviors involves team members lowering their voices and mumbling when communicating information. After the second day of training, this behavior is almost nonexistent. This reflects a basic problem for developing teams, who often do not communicate needed information and lower their voices when they do communicate so that others will not detect their errors. Thus, during the first phase of training, trainees should be instructed that certain kinds of errors are expected to occur at the beginning of training, and that the instructor will be sensitive to their feelings of confusion and uncertainty.

By the second day of training, team members appear to become more comfortable with the communication process. However, as the number of communications increases--the desirable outcome--so

does the number of errors; the opportunity for making errors goes up (see Tables 7 & 9). The most frequently recorded communication errors at this stage and after involve the use of improper terminology and the failure to transmit information in the proper order. By the time of the midterm, which usually occurs on the third day of training, the number of communication errors diminishes, falling below the level reported the first day. Greater awareness by the instructor of what is to be expected (e.g., errors) at different points in training should enable him to adapt his instructional approach more appropriately to the changing needs of the teams.

The development of effective communication behaviors appears to be particularly crucial for team success. Throughout the course of training, between 44% and 51% of the recorded ineffective behaviors reflect problems in communication. This, no doubt, reflects the importance attached by instructors to effective communication. Many instructors reported that this is the most important dimension.

Increasing Individual Competence

With respect to team performance, it has often been stated that "the whole is greater than the sum of its parts." However, the individuals comprising the team must come to training with some threshold level of individual competence in order for team training to be efficient. For example, plotters must know how to plot both the movement of the ship and the location of the target, or what other team members do cannot have much effect upon accomplishment of the mission.

Theoretically, team members, should have reached some minimal level of individual competence before they report for training. From time to time, however, trainees do report for team training without adequate individual skills. Indeed, a crew with all members ready for team training is a rarity. Interviews with the instructors indicated that two courses of action are available: (1) the instructor can take time to teach the individual skills, thereby reducing the time available for team training (a common practice), or (2) the team member may be sent back to the ship and a replacement may be requested (a rare event). The viability of the two alternatives is likely to depend on the extent of the deficiency. This recognition and practice is in agreement with the assertions of Dyer (1984), Hall and Rizzo (1975), and Johnston (1966) regarding the necessity for adequate individual competence and, as in this investigation, that of teamwork concepts. Indeed, both are needed if team training is to be successful.

Even if all team members possess at least minimal competency, some trainees will be more skilled than others. An important consideration in team training is the extent to which

trainees can compensate for one another's weaknesses or build on one another's strengths. Lower levels of competency might be tolerated in the noncritical positions if the remaining members are sufficiently skilled to compensate for the deficiency. In the event that the remaining members lack sufficient skill to permit such compensation, or if the trainee in question occupies a "critical" role, the instructor may be forced to seek a replacement.

Preparing Team Leaders

Individual competence appears to be particularly important in the case of the formal leader of a team, in this instance the Gunnery Liaison Officer (GLO). Data reported in Figure 7 and Table 10 of the Results section suggests a vital relationship between the individual performance of the GLO and the performance of the team as a whole. In the more effective teams, the instructors' ratings of the GLO increased through the midterm and remained relatively high thereafter (Figure 7). It is interesting to note that their highest rating occurred during the midterm when they were initiating the greatest proportion of their behaviors (Table 10). By contrast, the GLOs of less effective teams received consistently low ratings even though they initiated most of their behaviors. These results suggest that special attention needs to be directed toward the training of the GLO. It might be advantageous to supplement the GLO's training with specific instruction in team performance concepts such as effective communication, coordination, and cooperation. Such instruction should deal specifically with the proper (e.g., "diplomatic" and effective) timing and delivery of initiated behaviors. This would help to increase the likelihood that the formal leader will have learned the skills required to assume a full leadership role as the team approached the midterm, the point when the instructor is preparing to reduce his involvement in the team and assume the role of an observer and resource person.

Vaill (1978) has suggested that the importance of a leader's technical expertise has tended to be undervalued. Likewise, Yukl (1981) has identified a number of contingencies that require problem-solving skills of the leader. It seems reasonable to assume that problem-solving skills in a given area are preceded by technical competence. One of the contingencies described by Yukl occurs when the group operates in a hostile environment which on a periodic basis endangers its existence. The application to a military context is obvious.

Diagnosing

A crucial component of effective team training is diagnosis of the teams deficiencies. Once a diagnosis is made, the training program can be modified to provide remedies in areas of

weakness. As indicated earlier, the Critical Team Behaviors Form can be of considerable assistance in this regard. As shown in Table 9 of the Results section, this instrument is sensitive to differences in the performance of more effective and less effective teams. Specifically, a greater number of effective behaviors were recorded for teams who subsequently performed well on the final exam and the live firing than for those teams whose performance was less effective; no meaningful differences were detected for ineffective behaviors. It should be noted that all of the teams included in the study successfully completed the final, indicating that the instrument is sensitive to differences despite a restriction in range.

Diagnosis using this instrument is facilitated by the categorization of behaviors into the seven dimensions of teamwork skills: communication, cooperation, team spirit and morale, giving suggestions or criticisms, accepting suggestions or criticisms, coordination, and adaptability. Thus, patterns of effective and ineffective behaviors in specific skill areas could be detected, and instructors could made aware of which skills and knowledges require increased attention. Furthermore, the repeated use of this instrument during the course of training could provide feedback to the instructor regarding success in avoiding problems or correcting deficiencies. This would provide further alerting as to the need to modify his instructional approach based on the progress of the team (or lack thereof).

The behavioral items comprising the Critical Team Behaviors Form were provided by the instructors, using their terminology. This contributes to the meaningfulness and relevance of the items for the instructors, while also serving to increase the instructors' sensitivity to specific behaviors which could lead to enhanced or reduced performance. It is also worth noting that with practice the form, despite its length, becomes easier to use. In addition, there is the possibility of using a trouble shooting approach, incorporated in a handy guide and/or computer, to which entry is made by problem or symptom to uncover relevant underlying behaviors and action alternatives.

Training the Instructors

The generalization of the original model of team evolution and maturation to the NGFS site provides the basic framework for the development of a program of instruction for instructors. This framework, in conjunction with evidence for a shift in the salience of teamwork and taskwork factors, provides the basis for the development of norms describing the typical development of teamwork during the course of training. Once behavioral norms are established for various levels of team performance, the information can be presented to instructors as part of their own training. Instructors need to know the types of behaviors, both effective and ineffective, that can be expected to occur at each

stage of development. Critical behaviors can serve as benchmarks for tracking the progress of each team undergoing training. Furthermore, the effects of interventions, such as the imposition of external demands, should be presented as tools to be used to expedite team development. Videotapes of typical performance could be used to provide realism absent in the spoken or printed word. Furthermore, videotapes developed for training instructors could also be shown to team members, thereby providing goals which are understandable and meaningful to the team.

The existence of "critical" versus "noncritical" team positions should also be discussed and training should be provided to assist the instructors in identifying prerequisite threshold levels of individual performance. Based on the establishment of minimal criteria, decision rules should be developed to provide guidance in handling the problem of deficiencies in the individual skills of members. Objective measures of individual performance, which could identify deficiencies early on, would provide the instructors with greater versatility in remedying weaknesses.

THIS PAGE INTENTIONALLY LEFT BLANK.

RECOMMENDATIONS

Because this research was conducted within the context of school house training, most of the discussion has addressed the school situations. However, it must be noted that a major share of training takes place aboard the Navy's ships and stations under operational command. It should also be recognized that embedded training capability is being designed into new equipment, and this capability is becoming an ever enlarging component of the Navy's total training system. Thus, the reader should be reminded that applications of the current findings, such as the interventions suggested below, will inevitably and increasingly extend beyond school sites and become a part of the everyday concerns of operational units.

OVERVIEW

This section focuses on the development of interventions to improve team training. Its major purpose is to outline the range of potential interventions that might be considered for evaluation during the next phase of this research project. The discussion will not be exhaustive, but it will present a representative sample of the changes that are suggested by the current set of data. For purposes of this discussion, training systems will be defined as consisting of three major components: 1) instructional materials--such as the curriculum training objectives; 2) instructional technology--such as the NGFS trainer; 3) instructors--people assigned to carry out the training. Because a given intervention is expected to impact one of these components primarily, the following discussion of interventions will be divided into three sections corresponding to these three categories of training system components. However, this categorization is somewhat arbitrary because, given the interdependent nature of team training systems, almost all interventions must ultimately be expected to affect the entire training system. The interventions to be discussed in the following sections are summarized below. Each type of intervention will be considered separately, and specific examples of each will be provided.

Instructional Materials

* Modify the curriculum to include additional instruction concerning team interaction processes.

* Initiate new testing and/or goal setting procedures to increase team attention to taskwork and teamwork objectives.

* Integrate teamwork concepts with simulator exercises to enhance the practice of teamwork processes.

Instructional Technology

* Install audio and video recording systems to assist the instructor during diagnosis, evaluation, and feedback.

* Modify and install the IDAFT (Instructional Development of Automated Feedback Training) system in order to provide feedback that is more timely and relevant to teamwork skills.

* Develop other performance measurement tools (e.g., coding devices) to record behaviors in real time during training.

Instructors

* Provide additional specialized pipeline training in team oriented concepts for instructors who conduct team training.

* Train instructors in the use of the TEAM measurement instruments with refinements and modifications to fit specific missions that have been developed for use in diagnosis, feedback, and evaluation.

INSTRUCTIONAL MATERIALS

Curriculum

Several curriculum changes might be considered as enhancements to current team training systems. The general approaches suggested here are not new. However, because the TEAM data collection instruments and analytic procedures provide new methods for monitoring the the development of teams during training, these changes warrant new application to team training. Wexley and Baldwin (1986) have examined three post-training strategies which are designed to facilitate positive transfer of training to the job. Specifically, they evaluated strategies involving goal-setting, participative goal-setting (cf., Anderson & Wexley, 1983), and relapse prevention self-management (cf., Marx, 1986). Wexley and Baldwin's methodology could be applied in the current TEAM project to test the effects of these types of strategies on team training.

Another potential curriculum intervention would require the incorporation of principles concerning the evolution and maturation of teams into the introductory portions of training. Given the current evidence for the impact of teamwork factors during training, the highlighting of teamwork principles might be expected to increase the salience of teamwork processes and quicken the evolution and maturation of teams. Most training

focuses on the taskwork (or technical) aspects of training, with little or no emphasis on the variables that contribute to teamwork. Observations by experimenters in the current investigation have indicated that team building (teamwork development) usually occurred on an ad hoc basis during training. Formalizing the time and methods for team building, especially during training periods when teamwork has the highest salience for team members (see the Discussion section) could have a profound impact on training effectiveness.

Testing

Given (a) the existence of the "jelling" factor during the testing phases of NGFS training, and (b) reports from the instructors that teams seemed to become more unified at the midterm phase, it is possible that altering the testing procedures might have a positive impact on training. This is consistent with Gersick's (1985) observation that groups seem to redirect their energy as the nature of external demands become more salient to them. The establishment of a testing period earlier in training might provide a catalyst for the team to jell earlier, thus hastening the merger of the teamwork and taskwork factors.

A second testing intervention could consist of the implementation of a pretest of individual skills and knowledges to assist instructors in the initial evaluation of a team's capability. Such a test could also include measures of team performance levels that would be useful to the instructors in choosing their instructional strategy (see Guerette, et al., 1987). NGFS instructors indicated that the implementation of a pretest is highly desirable, and not readily available in the current system.

Simulator Exercises

As noted in the Discussion section, the presentation of novel situations during training can have a positive impact on team shaping processes. Such novel events could be added to the existing sets of simulator exercises to advance the team maturation process.

INSTRUCTIONAL TECHNOLOGY

Audio and Video Equipment

Experimentation with the use of video cameras in the current research has added some heuristic value relevant to potential interventions. This experience suggested that two intervention strategies are possible. First, it was noted by the

instructors that the videotapes provided information concerning behaviors that were missed in real-time training. Thus, videotape review of training sessions might improve the instructor's preparation for team performance feedback. Second, the development of video samples of desired behaviors for given exercises could be prepared (perhaps with instructors in each team position) in order to provide behaviors which could be modeled by the teams in training in a feedforward type paradigm (as well as to illustrate common defects to be avoided). Likewise, the ability to record the communications that occur during training sessions could provide vital information for instructors in preparing performance feedback.

IDAFT

The Instructional Development of Automated Feedback Training (IDAFT) system originally developed (Andrews & Uliano, in press) for the Fleet ASW training setting is proposed as a source of feedback information for instructors. The existing system focuses on individual performance variables, and it would have to be modified to include team performance parameters. Such a modification seems feasible. IDAFT could provide an additional source of performance feedback information, especially if the modifications included both taskwork and teamwork elements.

Coding Devices

As discussed earlier, the fact that the Critical Team Behaviors Form cannot be completed in real time, and the length of time required to complete the form, both need to be considered for change in future research and implementation in training settings. An intervention that might solve these problems is the use of a hand-held coding device (similar to inventory control devices used in supermarkets). Using such a device, instructors should be better able to record behaviors in real time. These could then be complied and printed out at the end of a training session.

INSTRUCTORS

Pipeline Training

NGFS instructors currently receive three weeks of training at the Instructor Training School. As a part of this training, it would seem worthwhile to provide instructors with additional training on the general team development process principles being uncovered by the current TEAM research effort. This additional training could include specific training on the curriculum and hardware interventions that might be implemented as enhancements to the current system. Also, an emphasis on the factors

identified in the TEAM model could increase the awareness of teamwork oriented skill requirements as well as technical task skill requirements, and enhance the understanding of their joint contribution to successful team training.

CONCLUSIONS

As was stated at the outset, the interventions highlighted above are neither all inclusive or highly detailed. They are presented to indicate how the results of the NGFS portion of the TEAM project can be translated directly into interventions which could substantially improve team performance, both in the short term and ultimately in the long-term. The next phase of the TEAM project will consist of (1) the selection of testable interventions based upon a comprehensive review of potential interventions in association with experts within and outside of the Navy, and (b) measurement of the effectiveness of the interventions that are selected for implementation. Based on the findings of that research, more definitive recommendations will be made concerning the relative efficacy of various team training interventions in current and future training systems.

THIS PAGE INTENTIONALLY LEFT BLANK.

REFERENCES

Alluisi, E. A. (1977). Lessons from a study of defense training technology. Educational Technology Systems, 5 (1), 57-76.

Anderson, J., & Wexley, K. N. (1983). Applications-based management development: A method to promote practical application of managerial and supervisory training. Personnel Administrator, 28, 39-43.

Andrews, D. H., & Uliano, K. C. (In Press). IDAFT: An instructor's diagnostic aid team training. Journal of Industrial Teacher Education.

Bales, R. F., & Strodtbeck, F. L. (1951). Phases in group problem solving. Journal of Abnormal and Social Psychology, 46, 485-495.

Baum, D. R., Modrick, J. A., & Hollingsworth, S. (1981). The status of Air Force team training for command and control systems (Report No. 81SRC14). Minneapolis, MN: Honeywell Systems and Research Center.

Bell, M. A. (1982). Phases in group problem-solving. Small Group Behavior, 13 (4), 475-495.

Bennis, W. G., & Shepard, H. A. (1956). A theory of group development. Human Relations, 9 (4), 415-437.

Caple, R. B. (1978). The sequential stages of group development. Small-Group Behavior, 9 (4), 470-477.

Cissna, K. N. (1984). Phases in group development: The negative evidence. Small-Group Behavior, 15 (1), 3-32.

COMNAVSURFLANTINST 3570.2C. (1982, July). Norfolk, VA: Department of the Navy, Commander, Naval Surface Force, United States Atlantic Fleet.

Denson, R. W. (1981). Team training: Literature review and annotated bibliography (AFHRL-TR-80-40). Wright Patterson Air Force Base, OH: Logistics and Technical Training Division, Air Force Human Research Laboratory.

Dyer, J. (1984). State-of-the-art review on team training and performance. Fort Benning, GA: Army Research Institute Field Unit.

Fisher, B. A. (1970). Decision emergence: Phases in group decision-making. Speech Monographs, 37 (1), 53-66.

Flanagan, J. C. (1954). The critical incident technique. Psychological Bulletin, 51, 327-358.

Fleishman, E. A., & Hempel, W. E., Jr. (1955). The relation between abilities and improvement with practice in a visual discrimination reaction task. Journal of Experimental Psychology, 42, 301-312.

Ford, J. K., MacCallum, R. C., & Tait, M. (1986). The Application of exploratory factor analysis in applied psychology: A critical review and analysis. Personnel Psychology, 39, 291-314.

Gersick, C. J. G. (1985). Time and transistion in work teams: Towards a new model of group development. Unpublished Manuscript.

Glickman, A. S., Goodstadt, B. E., Kavanagh, M. I., Bass, B. M. (1977). Support of ARI research on organizational effectiveness. Washington, D. C.: American Institute for Research.

Glickman, A. S., & Vallance, T. R. (1958). Curriculum assessment with critical incidents. Journal of Applied Psychology, 42, 329-335.

Goldin, S. E., & Thorndyke, P. W. (Eds.). (1980). Improving team Performance: Proceedings of the Rand team performance workshop (R-2606-ONR). Santa Monica, CA: Rand Corporation.

Goodstadt, B. E., Frey, R. L., & Glickman, A. S. (1975). Socialization processes and the adjustment of military personnel to army life. Washington, DC: American Institutes for Research.

Guerette, P. J., Miller, D. L., Glickman, A. S., Morgan, B. B., Jr., & Salas, E. (1987). Instructional processes in team training (NTSC Tech. Rep. TR87-017) Orlando, FL: Naval Training Systems Center.

Hall, E. R., & Rizzo, W. A. (1975). An assessment of U.S. Navy tactical team training (TAEG Report No. 18). Orlando, FL: Training Analysis and Evaluation Group.

James, L. R., Gustafson, S. B., & Sells, S. B. (1985). Final report: Development of effective leaders: The need to consider situational specificity verses cross-situational consistency (Contract No. NCOO14-80-C-0315). Arlington, VA: Group Psychology Program: Office of Naval Research.

Johnston, W. A. (1966). Transfer of team skills as a function of type of training. Journal of Applied Psychology, 50, 102-108.

Marx, R. D. (1986). Self-managed skill retention. Training and Development Journal, January, 54-57.

Morgan, B. B., Jr., Glickman, A. S., Woodard, E. A., Blaiwes, A. S., & Salas, E. (1986). Measurement of team behaviors in a Navy environment (NTSC Tech. Rep. No. TR-86-014). Orlando, FL: Naval Training Systems Center.

Nieva, V. F., Fleishman, E. A., & Rieck, A. (1978). Team dimensions: Their identity, their measurement and their relationships (Contract No. DAHC19-78-C-0001). Washington, DC: Response Analysis Corporation.

Salas, E., Blaiwes, A. [illegible] Reynolds, R. E., Glickman, A. S., & Morgan, B. B., Jr. [illegible]5). Teamwork from team training: New directions. Proceedings of the 7th Interservice/Industry Training Equipment Conference and Exhibition. Orlando, FL: American Defense Preparedness Association.

Terborg, J. R., Castore, C. H., & DeNinno, J. A. (1976, May). A longitudinal field investigation of the impact of group composition on group performance and cohesion. Paper presented at the meeting of the Midwestern Psychological Association, Chicago, IL.

Tuckman, B. W. (1965). Developmental sequence in small groups. Psychological Bulletin, 63, 384-399.

Tuckman, B. W., & Jensen, M. (1977). Stages of small group development revisited. Group and Organizational Studies, 2, 419-427.

Vaill, P. B. (1978). Toward a behavioral description of high-performing systems. In M. W. McCall, Jr. and M. M. Lombardo (Eds.), Leadership: Where else can we go? Durham, NC: Duke University Press.

Wexley, K. N., & Baldwin, T. T. (1986). Post-training strategies for facilitating positive transfer: An empirical exploration. Academy of Management Journal, 29, 503-520.

Yukl, G. A. (1981). Leadership in organizations. Englewood Cliffs, NY: Prentice-Hall.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX A

Criteria for the Selection of a Data Collection Site

APPENDIX A

Criteria for the Selection of a Data Collection Site

Primary Characteristics

Member Communication

* Extensive (verbal and nonverbal)
* Observable or trackable as much as possible for as many members as possible

Member Interaction

* Significant periods of performance time (more than 5 minutes)
* At least 2 members interacting at any one time throughout task

Member Interdependency Team

* As high as possible, with all working toward the same recognized goal
* Goal-oriented activities involving all or subsets of members
* Shared resources (information, KSAs)
* Sequenced or overlapping procedures

Situational Factors

* Stable, including training
* Newly formed teams
* Training is seen as necessary to job performance (high motivation)
* Initial skills training (prefer team training not individual skill training)
* Able to observe individual and team learning and improvement

Performance Measures

* Formative as well as summative criteria available
* Quantitative measures available or can be developed
* Able to track process and to identify intermediate outcomes
* Able to distinguish team from individual outcome and process measures

APPENDIX A (Continued)

Secondary Characteristics

Data Collection Feasibility

* Team composition
* Fleet willingness to cooperate
* Task structure
* Geographical proximity

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX B

Critical Team Behaviors Form

Date _____ Ship Name _____

Day _____ Exercise Name _____

Session _____

INSTRUCTIONS

During the last set of exercises that you observed, did you see any of these things happen that significantly affected work outcomes? If so, please

(1) X the positions of the team members who were involved; and

(2) Circle the X of the individual(s) who did what you marked.
NOTE: INS = Instructor; EXT = External (e.g., Spotter, Bridge, etc.)

In the first column marked "Impact" please indicate the number representing the level of impact that each of these incidents had on the team's performance using the scale at the top of each page. (1 = No Impact; 2 = Some Impact; and 3 = Major Impact).

In the last column on the sheets for Communication and Cooperation, please indicate the frequency with which the team member performed each item by indicating the appropriate number (1 = Rarely; 2 = Sometimes; 3 = Regularly; and 4 = Consistently). For example, if a team member communicated information out of order 60% of the time, you would put a three (3) in the blank beneath the column marked "Frequency."

Important events which happen infrequently are listed on the page entitled "Infrequent Incidents." Please read and become familiar with these items. It is only necessary to consider this page when a listed item has occurred.

Finally, the last page is reserved for any additional incidents that you observe that do not appear elsewhere. This page differs from the previous pages because it is necessary to write the incidents in the blanks.

TABLE OF CONTENTS

COMMUNICATION

1 = No Impact
2 = Some Impact
3 = Major Impact

1 = Rarely (0 -25%)
2 = Sometimes (26-50%)
3 = Regularly (51-75%)
4 = Consistently (76-100%

	IMPACT (1,2,3)	GLO	A GLO	CIC SUP	NAV PLT	TAR PLT	R/T TAL	R/T REC	NAV REC	INS	EXT	FREQUENCY (1,2,3,4)
1. Lowered his voice and mumbled when communicating information to other team members.												
2. Communicated information out of order.												
3. Added his own comments to the prescribed commands, thereby wasting time.												
4. Used improper terminology when communicating information.												
5. Failed to ask for clarification on a communication that was unclear.												
6. Asked for specific clarification on a communication that was unclear.												
7. Members were talking among themselves and missed a communication.												

COOPERATION

1 = No Impact
2 = Some Impact
3 = Major Impact

1 = Rarely (0 -25%)
2 = Sometimes (26-50%)
3 = Regularly (51-75%)
4 = Consistently (76-10

	IMPACT (1,2,3)	GLO	A GLO	CIC SUP	NAV PLT	TAR PLT	R/T TAL	R/T REC	NAV REC	INS	EXT	FREQUENCY (1,2,3,4)
1. Checked with other team members when uncertain about what to do next.												
2. Helped another member who was having difficulty with a task.												
3. Prompted another member on what he had to do next.												
4. Gave suggestions on how to do a task.												
5. Member who needed assistance asked for help.												
6. Tried to push another member out of the way and do his job for him.												
7. To help another member, performed a task that was not part of his job.												
8. Was uncertain what to do next and failed to ask for help.												

1 = No Impact

2 = Some Impact

3 = Major Impact

TEAM SPIRIT AND MORALE

	IMPACT (1,2,3)	GLO	A GLO	CIC SUP	NAV PLT	TAR PLT	R/T TAL	R/T REC	NAV REC	INS	EXT
1. Made positive statements to motivate the team.											
2. Patted another member on the back.											
3. Assisted another member when the latter had a difficult task to perform.											
4. Discussed ways of improving team performance.											
5. Formed subgroups or cliques.											
6. Argued among themselves.											
7. Praised another member for doing well on a task.											
8. Made negative comments or blamed another member for the failure of the team.											
9. Made a joke to lighten the tension.											
10. Allowed personality conflicts to interfere with work.											
11. Made negative comments about the team or training.											
12. Provided moral support to a member who had made a mistake.											

GIVING SUGGESTIONS OR CRITICISM

1 = No Impact

2 = Some Impact

3 = Major Impact

	IMPACT (1,2,3)	GLO	A GLO	CIC SUP	NAV PLT	TAR PLT	R/T TAL	R/T REC	NAV REC	INS	EXT
1. Raised question about incorrect procedure used by a senior member of the team.											
2. Called attention to a mistake made by another member without being negative.											
3. Noticed a mistake and did not mention it.											
4. Asked if the procedure or information was correct when he wasn't sure.											
5. Suggested to another member that he recheck his work so that he could find his own mistake.											
6. Gave unsolicited and unnecessary advice to another member.											
7. Raised his voice when correcting another member.											
8. Verbally reprimanded another member when this was necessary.											

ACCEPTANCE OF SUGGESTIONS OR CRITICISM

1 = No Impact

2 = Some Impact

3 = Major Impact

	IMPACT (1,2,3)	GLO	A GLO	CIC SUP	NAV PLT	TAR PLT	R/T TAL	R/T REC	NAV REC	INS	EXT
1. Asked what he had done wrong when told that he had made a mistake.											
2. Told other members to worry about their own jobs and let him alone.											
3. Argued with another member who said he had made a mistake.											
4. Tried to cover up his own mistake.											
5. Thanked another member for catching his mistake.											
6. Became hostile or defensive when criticized.											

5

COORDINATION

1 = No Impact

2 = Some Impact

3 = Major Impact

	IMPACT (1,2,3)	GLO	A GLO	CIC SUP	NAV PLT	TAR PLT	R/T TAL	R/T REC	NAV REC	INS	EXT
1. When finished one task, member began working on another task.											
2. Coordinated gathering of required information in an effective manner.											
3. Was not ready with information when another member needed it.											
4. Provided information that was needed before being asked for it.											
5. Was ready with information when other members needed it.											
6. Directed members on what to do next.											
7. Indicated that he was finished with a task before he really was so that he could beat the clock.											
8. When not busy with his job, watched what the other members of the team were doing.											
9. When serving as a backup for another member, confirmed information without checking it.											
10. Attempted to determine the cause of discrepant information before going on.											
11. Failed to provide information unless asked.											

ADAPTABILITY

1 = No Impact

2 = Some Impact

3 = Major Impact

	IMPACT (1,2,3)	GLO	A GLO	CIC SUP	NAV FLT	TAR FLT	R/T TAL	R/T REC	NAV REC	INS	EXT
1. Member was unable to adapt to information provided out of order.											
2. Performed a task outside of his job because the team needed to have the work done.											
3. Changed the way he performed a task when asked to do so.											
4. Made no attempt to recover missed information.											
5. Member was able to adapt to information provided in the wrong order.											
6. Made sure he had all of the information required to complete his job.											
7. Provided suggestions on the best way to locate an error.											
8. Refused to change the way he did a task even though he was doing it wrong.											

INFREQUENT INCIDENTS

1 = No Impact

2 = Some Impact

3 = Major Impact

	IMPACT (1,2,3)	GLO	A GLO	CIC SUP	NAV PLT	TAR PLT	R/T TAL	R/T REC	NAV REC	INS	EXT
1. Gave a different interpretation to information provided by another member because of errors previously made by that member.											
2. Indicated that he knows his job and shouldn't have to worry about someone else's job.											
3. Failed to assist another member who was having difficulty and let him fail.											
4. Member became overloaded and failed to ask for assistance.											
5. Wrote down notes for another team member on the performance of the latter's job.											
6. While waiting for information from another member, began to harass the other member.											
7. Ridiculed a member who had made a mistake.											
8. Tried to cover up a mistake made by another member.											

ADDITIONAL INCIDENTS

1 = No Impact

2 = Some Impact

3 = Major Impact

	IMPACT (1,2,3)	GLO	A GLO	CIC SUP	NAV PLT	TAR PLT	R/T TAL	R/T REC	NAV REC	INS	EXT
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX C

Overall Team Performance Form

OVERALL TEAM

PERFORMANCE

INSTRUCTIONS: Indicate below the score appropriate for rating the overall team performance up to this point in the training. This score should reflect current team performance only. Additionally, please provide the information concerning strengths and weaknesses in the place provided.

Team performance was very poor		Team performance was average		Team performance was very good
5	4	3	2	1

List three team strengths:

_____

_____

_____

List three team weaknesses:

_____

_____

_____

PLEASE CIRCLE SESSION: PRE-MIDTERM MIDTERM POST-MIDTERM

FINAL EXAM POST-TRAINING

APPENDIX D

Individual Performance Summary

INSTRUCTOR
INDIVIDUAL PERFORMANCE SUMMARY

INSTRUCTIONS: Upon completion of the current training session, please indicate the level of each individual's performance for the training session by circling the appropriate score provided. This performance measure should reflect the individual's performance of his assigned job only during the current training session.

	Member's performance was very poor		Member's performance was average		Member's performance was very good
TEAM MEMBER					
GLO	5	4	3	2	1
AGLO	5	4	3	2	1
CIC SUPER	5	4	3	2	1
NAV PLOT	5	4	3	2	1
TARGET PLOT	5	4	3	2	1
R/T TALKER	5	4	3	2	1
R/T RECORDER	5	4	3	2	1
BRIDGE TALKER	5	4	3	2	1

PLEASE CIRCLE SESSION: PRE-MIDTERM MIDTERM POST-MIDTERM

APPENDIX E

GLO Individual Performance Summary

GLO
INDIVIDUAL PERFORMANCE SUMMARY

INSTRUCTIONS: Upon completion of the current training session, please indicate the level of each individual's performance for the training session by circling the appropriate score provided. This performance measure should reflect the individual's performance of his assigned job only during the current training session.

	Member's performance was very poor		Member's performance was average		Member's performance was very good
TEAM MEMBER					
AGLO	5	4	3	2	1
CIC SUPER	5	4	3	2	1
NAV PLOT	5	4	3	2	1
TARGET PLOT	5	4	3	2	1
R/T TALKER	5	4	3	2	1
R/T RECORDER	5	4	3	2	1
BRIDGE TALKER	5	4	3	2	1

PLEASE CIRCLE SESSION: PRE-MIDTERM MIDTERM POST-MIDTERM

APPENDIX F

Trainee Self-Report Questionnaire

(Circle One)	NAV Plot	AGLO	GLO
TEAM	CIC SUP	NAV Recorder	R/T Talker
BILLET	R/T Recorder	Target Plot	Other _____

Think about the exercises in the last training session in which you took part. Circle the X that shows how much you agree or disagree with each statement. If you are "not sure", circle the X under that category. The "team" means you and the other CIC personnel in training with you from your ship.

The only people who are going to see your answers are the ODU researchers.

		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1.	Members of my team knew how to perform their required duties in this set of exercises.	X	X	X	X	X
2.	Members of my team discussed ideas about how to proceed in this set of exercises.	X	X	X	X	X
3.	Members of my team cooperated with each other during the exercises.	X	X	X	X	X
4.	Members of my team did not do their best in this set of exercises.	X	X	X	X	X
5.	My team felt that the success of our group was the most important objective of this exercise.	X	X	X	X	X
6.	Members of my team told me about the things I needed to know to do my job.	X	X	X	X	X
7.	Members of my team felt under pressure during this exercise.	X	X	X	X	X
8.	When members of my team had questions, we could turn to others for help.	X	X	X	X	X
9.	Members of my team had confidence in the accuracy of the information we got from the spotter, bridge, and plot.	X	X	X	X	X
10.	Communications were not always clear among members of my team.	X	X	X	X	X
11.	The activities of my team were well organized.	X	X	X	X	X
12.	I knew exactly what I was supposed to do during the exercises.	X	X	X	X	X

(OVER)

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
13. The final outcomes of this set of exercises were mostly the result of what our team members did; not what other people did.	X	X	X	X	X
14. My team sent accurate information to the spotter, bridge, and plot at the appropriate times.	X	X	X	X	X
15. My team felt that the success of individual members was the most important objective of this exercise.	X	X	X	X	X
16. Success in my job depended heavily on the actions of other team members.	X	X	X	X	X
17. It took too long to coordinate information in my team.	X	X	X	X	X
18. I completely understood how my position fits in with the work of other members of the team.	X	X	X	X	X
19. In this set of exercises, the leader of my team showed that he is concerned about the welfare of the team members.	X	X	X	X	X
20. I was not satisfied with my team's performance on these exercises.	X	X	X	X	X
21. This set of training exercises has improved the performance of our team.	X	X	X	X	X

Please answer the next two questions using the following choices. Put the appropriate number in the blank provided.

1. AGLO 2. Nav Recorder 3. CIC Sup 4. Target Plot 5. Instructor

6. R/T Talker 7. Nav Plot 8. R/T Recorder 9. GLO

22. Which individual was the "most valuable player" on the team during this set of exercises? (Choose only one) _____

23. Which individual was the "least valuable player" on the team during this set of exercises? (Choose only one) _____

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX G

Team Demographics Form

Instructions: The following information will remain confidential and is for research only. Each team member should fill in all questions carefully and completely.

INDIVIDUAL INFORMATION

WHAT IS YOUR CURRENT RANK _____ RATE _____

WHAT IS YOUR BILLET ON THE NAVAL GUNFIRE SUPPORT TEAM? _____

GLO _____	NAV PLOTTER _____	R/T TALKER _____
AGLO _____	TARGET PLOTTER _____	R/T RECORDER _____
CIC SUPERVISOR _____	NAV RECORDER _____	OTHER _____

HOW LONG HAVE YOU BEEN IN THE NAVY? (CIRCLE YEARS AND MONTHS)
YEARS <1 1 2 3 4 5 6 7 8 9 10 11-15 >15 MONTHS <1 1 2 3 4 5 6 7 8 9 10 11

HOW LONG HAVE YOU HELD YOUR CURRENT RANK OR RATE? (CIRCLE YEARS AND MONTHS)
YEARS <1 1 2 3 4 5 >5 MONTHS <1 1 2 3 4 5 6 7 8 9 10 11

HOW LONG HAVE YOU BEEN IN YOUR CURRENT COMMAND? (CIRCLE YEARS AND MONTHS)
YEARS <1 1 2 3 4 5 >5 MONTHS <1 1 2 3 4 5 6 7 8 9 10 11

HOW LONG HAVE YOU BEEN ASSIGNED TO THE NGFS TEAM AT YOUR CURRENT COMMAND? (CIRCLE YEARS AND MONTHS)
YEARS <1 1 2 3 4 5 >5 MONTHS <1 1 2 3 4 5 6 7 8 9 10 11

HOW LONG HAVE YOU HELD YOUR CURRENT BILLET ON THE NGFS TEAM AT YOUR CURRENT COMMAND? (CIRCLE YEARS AND MONTHS)
YEARS <1 1 2 3 4 5 >5 MONTHS <1 1 2 3 4 5 6 7 8 9 10 11

CHECK ANY OTHER OF THE FOLLOWING BILLETS THAT YOU HAVE HELD ON THIS TEAM.

GLO _____	NAV PLOTTER _____	R/T TALKER _____
AGLO _____	TARGET PLOTTER _____	
CIC SUPERVISOR _____	NAV RECORDER _____	R/T RECORDER _____

WHICH OF THE FOLLOWING SCHOOLS HAVE YOU ATTENDED IN THE LAST 3 YEARS?

A SCHOOL _____	LMET _____
C SCHOOL _____	RADAR NAV _____

IF YOU HAVE PREVIOUSLY COMPLETED THIS TRAINING WITH YOUR CURRENT COMMAND, INDICATE WHEN AND THE BILLET HELD. YOU MAY CHECK MORE THAN ONE.

	BILLET
IN THE LAST 6 MONTHS _____	_____
BETWEEN 12 & 6 MONTHS AGO _____	_____
BETWEEN 1 & 2 YEARS AGO _____	_____
BETWEEN 2 & 3 YEARS AGO _____	_____
OVER 3 YEARS AGO _____	_____

WHILE YOU HAVE BEEN IN YOUR CURRENT BILLET ON THIS TEAM HOW OFTEN HAVE YOU TRAINED WITH THIS TEAM? (CHECK)

MORE THAN TWICE A WEEK _____	1 TO 2 TIMES A QUARTER
1 TO 2 TIMES A WEEK _____	NEVER _____
1 TO 2 TIMES A MONTH _____	OTHER _____

APPENDIX H

Scoring Protocol for NGFS Qualification Exercises

APPENDIX H

SCORING PROTOCOL FOR NGFS QUALIFICATION EXERCISES

Prepared by
Randall L. Oser & Ben B. Morgan, Jr.

During NGFS training, the midterm and final exam exercises are scored according to procedures outlined in COMNAVSURFLANTINST 3570.2c, article 301. The overall strategy of the scoring procedure is to test the readiness of teams with respect to all the important aspects of shore bombardment and Naval Gunfire Support. The specific objective of this procedure is to " reward safe, accurate and timely fire support, and to penalize [teams] for unsafe practices, poor accuracy and tardy response" (p. III-1). Because team members are responsible for maintaining the equipment employed in Gunfire Support, teams are evaluated on both personnel and equipment performance; that is, no waivers are given for equipment malfunction. In addition, the scoring procedure places great emphasis on the safety of friendly troops. This is accomplished by assessing a separate "Endangering Friendly Troops Penalty" whenever a salvo impacts too closely to friendly troop positions.

The exercises are scored by the training instructor using standardized scoring sheets designed to address each specific exercise. In general, the scoring focuses on three major scoring factors: Gunfire Support procedures, Communication procedures, and the teams' ability to make timely responses during the training program. For each exercise, the scoring sheets specify the the missions that will take place in the testing session, number of "Maximum Credit" points allotted for each of several specific penalty areas, penalties to be assessed during the exercise, and information to assist the instructor in calculating the team's overall performance score. Thus, teams receive point credits based on the accuracy of their performance, the timeliness of their responses, and their ability to use proper Gunfire Support and Communication procedures. They are penalized for demonstrating inappropriate behaviors and for not demonstrating appropriate behaviors. That is, up to the limit established by the "Maximum Credit" allotment, the instructor deducts points for inaccurate, inappropriate, or untimely performances. Article 301 of the training manual provides detailed descriptions of the various credits and penalties associated with specific actions or lack of actions a team may demonstrate during the test sessions.

With respect to the Gunfire Support scoring factor, penalties may be assessed for specific behaviors such as the following: opening fire without command, reporting erroneous 'ready' commands, failing to respond to executive orders to fire, inability to use support equipment, violating a 'check fire'

order, failure to achieve a correct air burst, a fuze-setting error, providing inadequate illumination, and failure to deliver a full battery of salvos. Penalties related to Communication procedures include: mispronunciation of letters or numerals, failure to read back reports originated by the spotter, omission in read back of transmissions, communication security violations, misuse of 'over' and 'out', and failure to report according to doctrine. Additional penalties may be assessed in some instances when excessive time is required in the execution of the behavior.

Finally, it should be note that teams engage in the test exercises only after they have shown proficiency in the required pre-test exercises. The team must successfully demonstrate proficiency in the Basics and Pre-Midterm exercises prior to being given the Midterm test. Similarly, it must demonstrate proficiency in the Post-midterm exercises and have successfully passed the Midterm test prior to taking the Final exam.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX I

Factor Analysis of Self-Report Questionnaire Data

APPENDIX I

FACTOR ANALYSIS OF THE SELF-REPORT QUESTIONNAIRE DATA

This appendix presents further information regarding the factor analytic results of the self-report questionnaire. Presented here is information regarding reliability, factor structure and factor key development.

Factor Analysis Reliability

Table I-1 provides the alpha coefficients for the factor analyses for each phase.

Table I-1

Coefficients Alpha for the Self Report Questionnaire by Phase

Phase	Coefficient Alpha
Basic	.81
Premidterm	.86
Midterm	.86
Postmidterm	.89
Final	.87

Factor Interpretation

The procedures for interpreting the factors, presented in this section, were rather straightforward. "Key" items included for a particular factor were those having a loading of .40 or greater on that factor. Once the factor composition was determined (after varimax rotation, and using the .40 cut-off) only those factors which accounted for greater than 4.5% of the variance were included in subsequent analyses. Below that level factors were unstable and uninterpretable.

Table I-2 presents the loadings for each factor. The following code is used to identify which factors derive from a particular pairing:

(1) The first (capital) letter of each factor code

represents the phase-pairing to which it belongs (i.e., A denotes Basics with Premidterm; B denotes Premidterm with Midterm; C denotes Midterm with Postmidterm; and, D denotes Postmidterm with Final).

(2) The number in the factor code represents the number of the factor derived from the particular pairing.

(3) The second (lowercase) letter singles out the phase (in the pair) to which the factor belongs (i.e., b is Basics; r is Premidterm; m is Midterm; o is Postmidterm; and, f is Final). As an example, if a "b" appears, it refers to a factor where the items loading upon it came from the administration of the questionnaire during the Basics phase. In the A2-b example, "b" signifies that the items with appreciable loadings on the second factor derived from the Basics-Premidterm pairing came form the administration of the questionnaire during the Basics phase.

Table I-2 contains those items with loadings of at least .40 on more than one phase factor combination in the analysis of a given pair of phases (A, B, C, D). Table I-2 also shows the proportion of variance accounted for by each factor. It should be noted that in some cases, a factor contains items from two phases (i.e., B1-r, 1m and B4-r, 4-m). The loadings are listed separately for each phase, but the proportion of variance accounted for is listed for the overall factor.

To help the reader interpret this innovative adaptation of factor analysis and the rather complicated Table I-2, several examples will be provided here.

Under the B Phases heading, the first factor is 1-r, 1-m. This factor contains items from both the r Phase (Premidterm) and the m phase (Midterm). To facilitate interpretation the item loadings are listed in separate columns, according to the training phase from which they originated. For example, item 4 from the r Phase and from the m Phase both loaded on the first factor (denoted by the 1 in B1-r, 1-m). This should not be mistaken for an overlapping factor; the items from the two phases combined in B are part of the same factor (which accounts for 28.5% of the variance in the factor analysis of the B phase responses).

To reiterate, the definition of overlapping loadings requires loadings of .40 by an item on more than one of the factors appearing in the factor analysis of the phase combinations. Thus, the item 1 loadings that appear in factor B1-m and in B2-m are regarded as overlapping (denoted by the underline) because the loadings for the item are greater than .40

Table I-2

Significant Factor Loadings for Items in each Factor

Item No.	Paired Phases*																	
	A Phases			B Phases						C Phases			D Phases					
	1-r**	2-b	3-r	1-r	1-m	2-m	3-r	4-r	4-m	1-o	2-m	3-m	1-o	2-f	3-o	3-f		
1.		.73		.57	.55	.45	.46			.81		.49	.49	.55				
2.	.54							.80		.62			.45		.58	.54		
3.	.48	.67			.45			.56	.66	.64	.51			.64				
4.			.64	.55						.63	.60		.53	.44				
5.		.41					.59			.52		.53	.55	.55				
6.																		
7.													.49					
8.	.75							.58	.45	.50				.56	.68			
9.	.65	.41				.50	.50			.58		.43	.60	.58				
10.			.64	.71	.70					.41	.67		.62	.74				
11.		.69	.67	.56	.67					.80	.61		.75	.74				
12.	.59					.46	.61			.59		.55	.50					
13.																		
14.	.52	.43	.56		.48		.42			.55	.65	.40	.53	.61				
15.																		
16.																		
17.		.52	.65	.57	.67					.53	.71		.65					
18.	.71					.41	.44			.52		.58						
19.						.67	.52			.41		.65						
20.		.44	.61	.59	.60					.60	.61		.69	.48				
21.	.43		.40			.75	.57			.64		.74	.61	.69				
Percentage of Variance																		
	22.0	7.6	5.5	28.5		8.0	5.8	4.6		26.0	8.8	6.0	25.8	8.4	6.1			

Key:

* A = Basic Phase with Premidterm Phase
B = Premidterm Phase with Midterm Phase
C = Midterm Phase with Postmidterm Phase
D = Postmidterm Phase with Final Phase

** b = Basic Phase
r = Premidterm Phase
m = Midterm Phase
o = Postmidterm Phase
f = Final Phase

1 = first factor of the pairing
2 = second factor of the pairing
3 = third factor of the pairing
4 = fourth factor of the pairing

on more than one phase factor combination. Furthermore, since the difference between the loadings was less than .20, the item was not included in the final list of key items. Item 14 in factors C2-m and C3-m is an example of where there is overlap, but the difference between the loadings is greater than .20. Therefore, only the loading of the item not found in the final list of factor items is underlined (.40).

Based on the results presented in Table I-2, there appear to exist two strong and persistent factors (teamwork-centered and taskwork-centered), plus a late emerging three item factor (team jelling), which account for significant amounts of the variance. Caution must be exercised when interpreting a three item factor because its reliability may be questionable. However, this suggests that future revisions of the questionnaire should include more items related to that team-jelling factor because it may uncover an important set of influences. The following discussion considers the factors that derive from the pairing of phases.

Basics and Premidterm (A). In the A phases, there are three factors which satisfy the standard established for proportion of total variance accounted for. The three factors accounted for a total of 35.1% of the variance with a single Phase b factor (2-b) and two Phase r factors (1-r and 3-r).

Factor 2-b (the basics-skill factor) accounted for 7.6% of the variance. Among the items included (1, 2, 3, 5, 9, 11, 14, 17, and 20) are those relating to aspects of performance, coordination, cohesion, and communication. In the Basics phase, the first stage of training, it appears that members perceive the team to be confronting a broad spectrum of learing requirements including how to work together as a team, as well as how to perform their basic technical task functions. This basics-skill factor reflects both team forming activities (items 2, 3, 9, 11, 14, and 17; coordination, cohesion, communication) and task performance aspects (items 1, 5, and 20). The relevance of these aspects at this stage is supported by the demographics data and instructor reports indicating that often half or more of the members are new to the team when the training begins. The factors emerging in the Basics phase seem to reflect dynamic processes that operate to bring the team members to a common level of skill so that they can begin training for specific gunfire support missions.

There were two Phase r factors (1-r and 3-r) emerging from this analysis. One factor (1-r) can be called a "teamwork-centered" factor. Factor 1-r consists of items (2, 3, 8, 9, 12, and 18) that deal with coordination, communication, and cohesion. Essentially, these items deal with those perceptions of the team members bearing upon activities that involve working with or for other team members and that demonstrate interdependence. Representative of this factor are items (e.g., 2 and 8)

reflecting the degree to which one's work behaviors fit in with the activities of other members; like turning to other team members for help, and discussing ideas about how to proceed in the firing mission exercises. This factor accounted for 22.0% of the variance.

The second factor (3-r) can be labelled a "taskwork-centered" factor. It accounted for 5.5% of the variance. As contrasted with the teamwork factor, the taskwork factor is made up of items that deal with organization and performance of work tasks. For example, items 11, 17, and 20 reflect the degree to which the activities of the team were well organized, the amount of time it took to coordinate information, and the evaluation of team member performance. It can be seen that the items which are part of this factor pertain to the process of organizing to complete the task as well as achieving the desired performance outcomes.

Of particular interest is the fact that the teamwork factor accounts for the greatest amount of variance of the A factors. This provides empirical support for the assumption that development of "teamwork" and "teamness" are perceived as essential elements of a properly functioning team. It appears noteworthy that early in the evolution of the team, an emphasis is placed on the development of "teamness". This may in part represent the "newness" of many of the team members inasmuch as they must learn how to work with each other in order to carry out particular tasks. The amount of practice the team has had before arriving at NGFS also may affect the importance of the "teamness" factor in this early pairing. For example, if a team did not practice NGFS before arrival at the simulator, relatively more time would need to be spent developing team skills, compared to a team arriving at the trainer well practiced. In the latter case, the "teamness" might already exist. Reports from instructors indicate that the norm is for a team to have little or no practice working together before arrival at the school.

Premidterm and Midterm (B). Four factors, including two which contain items from more than a single phase (1-r. 1-m, 2-m, 3-r, and 4-r, 4-m) resulted from this analysis of B phases. The first factor (1-r, 1-m), a taskwork factor, contains items from both Phases r and m and accounts for 28.5% of the variance. A clearer explanation of this factor is achieved by separating the tems from the two phases, 1-r and 1-m. For 1-r the items in this taskwork factor (items 4, 10, 11, 17, and 20) are identical to those found in A3-r from the previous pairing. The items from 1-m in the taskwork factor (items 3, 10, 11, 14, 17, and 20) are similar to those found in 1-r. Where differences occur, specifically the addition of two additional items (3 and 14), the loadings on those items are the lowest for the factor. These additional items may indicate the beginning emergence of a maturation or integration process in the team that facilitates successful completion of tasks.

The second and third factors (2-m and 3-r) both reflect aspects of teamwork-centered activities accounting for 8.0% and 5.8% of the variance respectively. These two factors are quite similar. One new item (5) in 3-r, concerned with whether or not the team felt that the success of the group was the most important objective of the exercise, may reflect the differences between the two phases. Phase r can be regarded as a learning phase in which team members are learning to carry out specific missions. Phase m, on the other hand, is definitely a performance evaluation phase. The team must successfully complete the Midterm phase in order to move ahead to complete the training course. It is not surprising that success of the group is perceived by its members as crucial here, given the testing situation.

Factor 4-r, 4-m contains items from both Phase r (Premidterm) and Phase m (Midterm). This factor accounts for 4.6% of the variance and contains items that show the members to be acknowledging increasingly close collaboration, affiliation, cohesion, and mutual supportiveness. Items 2, 3, and 8 reflect exchange of ideas, turning to others for help, and other forms of cooperation. These reflect what the instructors refer to as "jelling", a process that may be accelerated here because the Midterm phase (Phase m) is a cruical point in the life cycle of the team.

Perhaps the most significant difference between the A Phases (b and r) analysis and th B Phases (r and m) analysis is that in the former the teamwork factor accounted for most of the variance, while in the latter, taskwork variables accounted for most of the variance. This may be due in part, to the team approaching a testing situation. Additionally, this findings suggest that a certain level of development of teamwork skills must be attained before the full potential for development of the team's taskwork skills can be realized.

Midterm and Postmidterm (C). This C Phases iteration produced three factors (1-o, 2-m, and 3-m). Factors 2-m (items 3, 4, 10, 11, 14, 17, and 20) and 3-m (items 5, 9, 12, 18, 19, and 21) again represent taskwork and teamwork, accounting for 8.8% and 6.0% of the variance, respectively. These factors are identical in item makeup with those found in the previous pairing (B Phases) for the factors containing items resulting from the Midterm phase. That is, factors B1-m and B2-m contain the same items as C2-m and C3-m, though there are some minor differences in the loadings.

Factors 1-o accounts for the largest percentage of the variance, 26.0%. This factor is different than previous factors. There is a convergent transformation; there is no longer a clear separation of teamwork and taskwork items (1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 14, 17, 18, 19, 20, and 21). A merging of the two factors into a single factor has occured. The items that form

the teamwork factor (3-m) and taskwork factor (2-m) are all found in factor 1-o; the merged factor. Some of the items (2, 8) in 1-o not found in 2-m and 3-m can be found in B4-m the team jelling factor.

Postmidterm and Final (D). In the D Phases analysis, three factors emerge that account for more than 5% of the variance, including a factor containing items from two phases (1-o, 2-f, 3-o, 3-f). Two of the factors 1-o (items 1, 4, 5, 7, 9, 10, 11, 12, 14, 17, 20, and 21) and 2-f (items 1, 3, 4, 5, 8, 9, 10, 11, 14, 20, and 21) are the merged factors similar to C1-o found in the previous iteration.

Factor 3-o, 3-f, accounting for 6.1% of the variance, is made up of two items, one from Phase o (item 8) and one from Phase f (item 2). The items are very similar to those which comprise the jelling factor (B4-r, 4-m) in the B Phases analysis. The similarity between Phases r and m and Phases o and f is that both of them include testing situations. It may be that when teams are being tested, the need for the team to jell--to become more cohesive and mutually supporting--becomes more compelling, so that loadings concentrate in separate factors rather than being assimilated as part of the teamwork factor as in the A Phases.

A summary of the proportion of variance accounted for by each factor in the respective phases is provided by Table I-3.

Table I-3

Summary Of Variance Accounted For By Factors Identified For Each Phase Of Team Training

	Factor Identification			
TRAINING PHASE	TEAMWORK	TASKWORK	TEAM/TASK	JELLING
Basics			7.6	
Pre-Midterm	22.0 5.8	5.5		
Pre-Midterm/Midterm				4.6
Midterm	8.0	8.8		
Post-Midterm			26.0 25.8	
Post-Midterm/Final				6.1
Final			8.4	

Constructing Profiles of Perceptions

Table I-4 presents the data in Table I-2 in a form designed to make easier the comparison of factors. It represents a step in the direction of constructing a small number of keys that could be used to provide factor profile scores for individuals. These profiles could then be aggregated to provide profiles of teams that show status and/or change at different points in time (i.e., phases of training) based upon the Trainee Self-Report Questionnaire responses which the instructional staff could use in tailoring training to fit the needs of teams at different points in their development. There follows a description of how such keys were built.

To begin with, guidelines were established to maximize the independence of the factors (i.e., minimize, insofar as possible, the correlations among the dimensions measured by the factor keys). A first sort identified items that had loadings of .40 or above. Where there was "overlap," loadings of .40 and above on two factors in the same phase of a given analysis (underlined in Table I-2), the rule imposed was that when the difference in loadings on the two factors was .20 or more the item would be assigned to the key of the factor on which it had the higher loading. Items that did not meet these requirements were dropped from the pool. Those that remained are shown in Table I-4.

Inspection of Table I-4 led to the establishment of three keys based upon distinguishable patterns of items. The teamwork-centered profile consists of items 5, 9, 12, 18, 19, and 21. (See Appendix F for a copy of the Trainee Self-Report Questionnaire items). These items were chosen for the profile because they were generally found in the teamwork-centered factor across all pairings. The profile for the task-centered factor consists of items 4, 10, 11, 17, and 20. The profile for the final factor only appears at the Premidterm and Midterm pairing. Yet, the amount of variance that it accounts for indicates that it is relevant to the change in the teams over time. The items contained in this profile are 2, 3, and 8. This is the team "jelling" factor. Given that these are only three items in this factor, similar items could be added to future revisions of the Trainee Self-Report Questionnaire in order to increase reliability.

Table I-4

Items by Item Number in each Factor
After Deletion of Overlaps

Paired Phases*																			
A Phases				B Phases						C Phases				D Phases					
**																			
1-r	2-b	3-r		1-r	1-m	2-m	3-r	4-r	4-m	1-o	2-m	3-m		1-o	2-f	3-o	3-f		
	1									1				1	1				
2	2							2		2							2		
3	3				3			3	3	3	3				3				
		4		4						4	4			4	4				
	5						5			5		5		5	5				
														7					
8								8	8	8					8	8			
9	9					9	9			9		9		9	9				
		10		10	10					10	10			10	10				
	11	11		11	11					11	11			11	11				
12						12	12			12		12		12					
	14				14		14			14	14			14	14				
	17	17		17	17					17	17			17					
18						18	18			18		18							
						19	19			19		19							
	20	20		20	20					20	20			20	20				
						21	21			21		21		21	21				

Key: * A = Basic Phase with Premidterm Phase
B = Premidterm Phase with Midterm Phase
C = Midterm Phase with Postmidterm Phase
D = Postmidterm Phase with Final Phase

** b = Basic Phase
r = Premidterm Phase
m = Midterm Phase
o = Postmidterm Phase
r = Final Phase

1 = first factor of the pairing
2 = second factor of the pairing
3 = third factor of the pairing
4 = fourth factor of the pairing